December 12, 2001

Christine Todd Whitman, Administrator
U.S. Environmental Protection Agency
P. O. Box 1473
Merrifield, VA 22116

RE: Olefins Panel Test Plan for High Benzene Naphthas Category, HPV Registration No.

Dear Ms. Whitman:

The Olefins Panel of the American Chemistry Council submits its test plan for the High Benzene Naphthas Category under the High Production Volume (HPV) Challenge Program. This CAS numbers included in this category are listed in the attached table.

In preparing this test plan, the Panel has given careful consideration to the principles contained in the letter EPA sent to all HPV Challenge Program participants on October 14, 1999. As requested by EPA in that letter, the Panel has sought to maximize the use of scientifically appropriate categories of related chemicals and of structure activity relationships. The Panel has coordinated with other industry groups covering related chemicals. Additionally, and also as requested in EPA's letter, in analyzing the adequacy of existing data, the Panel has conducted a thoughtful, qualitative analysis rather than use a rote checklist approach. The Panel has taken the same thoughtful approach when developing this test plan and believes it conforms to those principles.

If you have any questions, please contact Elizabeth Moran, Manager of the Olefins Panel at (301) 924-2006 or Elizabeth_Moran@americanchemistry.com.

Courtney M. Price
Vice President, CHEMSTAR

cc: C. Auer, EPA
B. Leczynski, EPA
S. Russell, ACC
J. Keith, ACC

CAS Numbers and Descriptions Associated with Streams in the High Benzene Naphthas Category

CAS Number	CAS Number Description
64741-99-7	Extracts, petroleum, light naphtha solvent
64742-49-0	Naphtha, petroleum, hydrotreated light
64742-73-0	Naphtha, petroleum, hydrodesulfurized light
64742-83-2	Naphtha, petroleum, light steam-cracked
64742-91-2	Distillates, petroleum, steam-cracked
67891-79-6	Distillates, petroleum, heavy arom.
67891-80-9	Distillates, petroleum, light arom.
68410-97-9	Distillates, petroleum, light distillate hydrotreating process, low-boiling
68475-70-7	Aromatic hydrocarbons, C6-8, naphtha-raffinate pyrolyzate-derived
68476-45-9	Hydrocarbons, C5-10 arom. conc., ethylene-manuf.-by-product
68526-77-2	Aromatic hydrocarbons, ethane cracking scrubber effluent and flare drum
68606-10-0	Gasoline, pyrolysis, debutanizer bottoms
68606-28-0	Hydrocarbons, C5 and C10-aliph. and C6-8-arom.
68921-67-5	Hydrocarbons, ethylene-manuf.-by-product distn. residues
68955-29-3	Distillates, petroleum, light thermal cracked, debutanized arom.
68956-52-5	Hydrocarbons, C4-8
68956-70-7	Petroleum products, C5-12, reclaimed, wastewater treatment
69013-21-4	Fuel oil, pyrolysis
8030-30-6	Naphtha

Note: The definitions, found in the TSCA Chemical Substance Inventory, for the CAS numbers included in this group are vague with respect to composition. Therefore, it is not uncommon to find that the same CAS number is correctly used to describe different streams (compositions) or that two or more different CAS numbers are used to describe the same stream (composition).

AR201-13436A

HIGH PRODUCTION VOLUME (HPV)

CHEMICAL CHALLENGE PROGRAM

TEST PLAN

For The

High Benzene Naphthas Category

Prepared by:

American Chemistry Council
Olefins Panel
HPV Implementation Task Group

December 18, 2001

PLAIN ENGLISH SUMMARY

The High Benzene Naphthas Category was developed for the HPV Program by grouping ethylene manufacturing streams (products) that exhibit commonalities from both manufacturing process and compositional perspectives. The 19 CAS Numbers in the category are associated with ten streams. These 10 streams, which are commercial products or isolated intermediates, contain significant levels of benzene (generally greater than 10% and averaging about 55%).

All streams in this category are subject to the Occupational Safety and Health Administration (OSHA) Benzene Standard (29 CFR 1910.1028). Those streams containing 1,3-butadiene are subject to the OSHA Butadiene Standard (29 CFR 1910.1051). OSHA Permissible Exposure Limits exist for all major components. Benzene, as the predominant component in most streams, is expected to be the key driver with respect to health effects endpoints within the SIDS battery of tests. However, as the concentration of benzene is decreased and the concentrations of other components are increased, the observed effects of benzene are expected to diminish and the effects of other components are expected to increase. The major chemical components of the streams in the High Benzene Naphthas Category have been extensively tested for human health toxicity endpoints and some data are available for other components and for two streams. Additional supporting data for components of the High Benzene Naphthas streams, tested either individually or as components of other streams or mixtures, will be collected for other test plans within the Olefins Panel's HPV program, by other consortia participating in the HPV or ICCA programs, or for chemicals sponsored in the OECD SIDS program. Hence, the basic strategy of this screening level test plan for characterizing the human health hazards of this category is to evaluate data for the components of the streams, as well as data for mixtures of category components and analogous mixtures (existing data and data being developed by other test programs). These data are expected to provide sufficient information to develop scientific judgment-based characterizations of the human health effects of streams in this category for purposes of satisfying HPV program requirements. Therefore, no additional human health toxicity testing is proposed.

Data will be developed and/or identified to adequately characterize relevant physicochemical endpoints in the HPV Chemical Challenge Program.

Existing data provide sufficient information to adequately characterize the biodegradability and aquatic toxicity of products in this category. Therefore, no additional biodegradation or aquatic toxicity testing is proposed.

Information or data will be developed on the potential of products in the High Benzene Naphthas Category to photodegrade, hydrolyze, and partition within the environment.

EXECUTIVE SUMMARY

The Olefins Panel (Panel) of the American Chemistry Council and the Panel's member companies hereby submit for review and public comment the test plan for the "High Benzene Naphthas" Category under the Environmental Protection Agency (EPA) High Production Volume (HPV) Chemical Challenge Program (Program). It is the intent of the Panel and its member companies to use new information in conjunction with a variety of existing data and scientific judgment/analyses to adequately characterize the SIDS (Screening Information Data Set) human health, environmental fate and effects, and physicochemical endpoints for this category in satisfaction of HPV Program requirements.

The High Benzene Naphthas Category was developed for the HPV Program by grouping ethylene manufacturing streams that exhibit commonalities from both manufacturing process and compositional perspectives. The 19 CAS Numbers in the High Benzene Naphthas Category are associated with ten streams. The ten streams are commercial products or isolated intermediates. The category includes hydrocarbon product streams associated with the ethylene industry that contain significant levels of benzene, generally with a benzene content greater than 10% and averaging about 55%. This grouping of CAS numbers represents hydrocarbon streams with a carbon number distribution that is predominantly C5 – C11, through components boiling at 650°F or higher.

Human Health Effects

All streams in this category are subject to the Occupational Safety and Health Administration (OSHA) Benzene Standard (29 CFR 1910.1028). Those streams containing 1,3-butadiene are subject to the OSHA Butadiene Standard (29 CFR 1910.1051). OSHA Permissible Exposure Limits exist for all major components. Benzene, as the predominant component in most streams, is expected to be the key driver with respect to health effects endpoints within the SIDS battery of tests, with genotoxicity and hematotoxicity the effects most likely to be seen. However, as the concentration of benzene is decreased and the concentrations of other components are increased, the observed effects of benzene are expected to diminish and the effects of other components are expected to increase.

Benzene has a robust toxicity dataset and has completed the OECD SIDS program. No further testing of benzene is needed for the HPV Chemical Challenge Program. The other major chemical components of streams in the High Benzene Naphthas Category have been extensively tested for human health toxicity endpoints, and all components present in the streams at concentrations greater than 5% have been tested in at least one toxicity study. Those components having only limited data lack structural alerts for mammalian toxicity and data exist for structural analogs. Some data are available for one High Benzene Naphthas stream [Hydrotreated C6-C8 Fraction] and a stream similar to the Pyrolysis Gasoline streams. Some data are also available regarding interactions between certain components that impact metabolism and toxicity. Additional supporting data for components of the High Benzene Naphthas streams, tested either individually or as components of other streams or mixtures, will be collected for other test plans within the Olefins Panel's HPV program, by other consortia participating in the HPV or ICCA programs, or for chemicals sponsored in the OECD SIDS program.

Hence, the basic strategy of this screening level test plan for characterizing the human health hazards of this category is to evaluate data for the components of the streams, as well as data for mixtures of category components and analogous mixtures (using existing data and data being developed by other test programs). These data are expected to provide sufficient information to develop scientific judgment-based characterizations of the human health effects of streams in this category in satisfaction of HPV program requirements. Based upon examinations of stream compositions and existing toxicity data, there is minimal likelihood for the appearance of unexpected or remarkable biological findings in testing of these streams. Therefore, no additional human health toxicity testing is proposed.

Physicochemical Properties, Environmental Fate, and Aquatic Toxicity

Existing measured data will be identified to adequately characterize physicochemical endpoints in the HPV Chemical Challenge Program. In addition, calculated data will be developed to characterize the physicochemical endpoints for selected chemicals in products from this category and compared with the existing measured data.

The strategy for characterizing the biodegradability and aquatic toxicity of products in this category is to evaluate data on component chemicals contained by products in this category and similar complex products. Read across biodegradation data show that products in the High Benzene Naphthas Category have the potential to exhibit a high extent of biodegradability. Read across aquatic toxicity data show that products in the High Benzene Naphthas Category have the potential to produce a moderate level of toxicity in freshwater algae and acute toxicity in freshwater fish and invertebrates. Existing data provide sufficient information to adequately characterize the biodegradability and aquatic toxicity of products in this category. Therefore, no additional biodegradation or aquatic toxicity testing is proposed.

The chemical components in these products are relatively volatile, and if released they would be expected to partition to the air phase to a significant extent. In the air, they are subject to rapid physical degradation through hydroxyl radical attack. Therefore, as a result of both biological and physical degradation processes, these products are not expected to persist in the environment. Information has not been developed on the potential of products in this category to photodegrade, hydrolyze, and partition within the environment. Therefore, information or data will be developed to characterize these endpoints in satisfaction of HPV program requirements.

LIST OF MEMBER COMPANIES
THE OLEFINS PANEL

The Olefins Panel includes the following member companies:

ATOFINA Petrochemicals, Inc.*
BP Chemical Company
Chevron Phillips Chemical Company
The Dow Chemical Company
E. I. du Pont de Nemours and Company
Eastman Chemical Company
Equistar Chemicals, LP
ExxonMobil Chemical Company
Formosa Plastics Corporation, U.S.A.
The Goodyear Tire & Rubber Company*
Huntsman Corporation
Koch Industries
NOVA Chemicals Inc.
Noveon, Inc*
Sasol America, Inc.
Shell Chemical Company
Sunoco, Inc.
Texas Petrochemicals Corporation*
Westlake Chemical Corporation
Williams Olefins, LLC

* These companies are part of the Olefins Panel but do not produce streams in the High Benzene Naphthas Category.

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TEST PLAN FOR THE HIGH BENZENE NAPHTHAS CATEGORY

I. INTRODUCTION

The Olefins Panel (Panel) of the American Chemistry Council and the Panel's member companies have committed to develop screening level human health effects, environmental effects and fate, and physicochemical data for the High Benzene Naphthas Category under the Environmental Protection Agency (EPA) High Production Volume (HPV) Chemical Challenge Program (Program).

In preparing this test plan, the Panel has given careful consideration to the principles contained in the letter EPA sent to all HPV Challenge Program participants on October 14, 1999. As directed by EPA in that letter, the Panel has sought to maximize the use of scientifically appropriate categories of related chemicals and structure activity relationships. Additionally, and also as directed in EPA's letter, in analyzing the adequacy of existing data, the Panel has conducted a thoughtful, qualitative analysis rather than use a rote checklist approach. The Panel has taken the same thoughtful approach when developing its test plan. The Panel believes its test plan conforms to the principles articulated in EPA's letter.

This plan identifies CAS numbers used to describe process streams in the category, identifies existing data of adequate quality for substances included in the category, and outlines activities to develop screening level data for this category under the Program. The objective of this effort is to identify and/or develop sufficient test data and/or other information to adequately characterize the human health effects and environmental effects and fate for the category in accordance with the EPA HPV Program. Physicochemical data that are requested in this program will be calculated as described in EPA guidance documents. In addition, measured data will be provided for selected products in this category where readily available.

II. DESCRIPTION OF THE HIGH BENZENE NAPHTHAS CATEGORY

A. The Category

The High Benzene Naphthas Category was developed for the HPV program by grouping ethylene manufacturing streams that exhibit commonalities from both manufacturing process and compositional perspectives. The 19 CAS numbers listed in Table 1 describe 10 streams which are complex products containing many components. Certain single streams are correctly represented by more than one CAS number, and a CAS number may be applicable to more than one stream. A description of the ethylene and associated stream production processes is included in Appendix I. A list of the other ethylene manufacturing stream categories being sponsored by the American Chemistry Council Olefins Panel is shown in Table 11.

The category includes hydrocarbon product streams associated with the ethylene industry that contain significant levels of benzene, generally with a benzene content greater than 10% and averaging about

55%. In some cases, petroleum refinery streams may be combined with intermediate streams from the ethylene unit and coprocessed to produce these products. This grouping of CAS numbers represents hydrocarbon streams with a carbon number distribution that is predominantly C5-C11, through components boiling at 650°F or higher. Pyrolysis gasoline is included in this category. The typical compositions of streams in this category are listed in Table 2.

The CAS Numbers in the High Benzene Naphthas Category are associated with the following streams, which are commercial products or isolated intermediates:

Pyrolysis Gasoline
Pyrolysis C6 Fraction
Pyrolysis C6-C8 Fraction
Pyrolysis C5-C6 Fraction
Hydrotreated C6 Fraction
Hydrotreated C6-C7 Fraction
Hydrotreated C6-C8 Fraction
Quench Loop Pyrolysis Oil and Compressor Oil
Recovered Oil from waste water treatment
Extract from Benzene Extraction

Descriptions of the ten streams associated with the High Benzene Naphthas Category are presented below:

1. Pyrolysis Gasoline

Pyrolysis Gasoline (Pygas) consists predominantly of C5+ hydrocarbons produced by the ethylene cracking furnaces. Typically the stream is derived from (1) the bottoms product from the debutanizer, (2) oils separated from furnace effluent quench systems, and (3) "drips" or condensate resulting from compression of the cracked gas. The oils from the quench systems and the "drips" may be stabilized to remove lights before blending with Pygas from the other sources. Depending on the plant configuration, Pygas may contain all of these intermediate streams, or the quench oils and stabilized drips may be transferred as separate streams. Low concentrations (e.g. 3% total) of C4 and lighter hydrocarbons may be present in the stream. A detailed analysis of Pygas may identify 60 or more hydrocarbon components or component groups, primarily unsaturated hydrocarbons and aromatics. Benzene, toluene, and dicyclopentadiene together may account for more than 50% of a Pygas stream and typically no other single component is present at a level greater than about 5%. The benzene concentration of Pygas is typically about 40% and the reported values range from 15 to 62%. The concentrations of individual hydrocarbon components in Pygas vary depending on the type of feedstock used by the ethylene plant, the mode of operation of the cracking furnaces (i.e. severity) and the ethylene process configuration. One non-typical Pygas stream is reported to contain vinylacetate at a concentration of up to about 10%. Vinylacetate is not typically found in ethylene process streams.

2. Pyrolysis Gasoline Fractions (Pyrolysis C6, C6-C8, and C5-C6 Fractions)

Pyrolysis gasoline is separated by distillation into various boiling-point-range fractions as intermediates in preparation for further processing. In some cases, petroleum refinery streams such as a C6 reformate fraction are combined with the pyrolysis gasoline prior to this separation. Similar to the situation for Pygas, the compositions of these fractions vary depending on the ethylene process feedstock and the other operating variables.

(a) Pyrolysis C5-C6 Fraction

The carbon number distribution for this stream is predominantly C5 to C6. One typical composition for this stream is reported as 70% benzene and 10% pentenes.

(b) Pyrolysis C6 Fraction

The carbon number distribution for this stream is predominantly C6. Reported compositions vary from 35 to 77% benzene, 0.5 to 5% toluene with the balance primarily C6 non-aromatics, which are expected to be largely unsaturates.

(c) Pyrolysis C6-C8 Fraction

This stream has a carbon number distribution that is predominantly C6 to C8. The reported compositions range from 30 to 80% benzene, 15 to 25% toluene and 3 to 23% C8 aromatics.

3. Hydrotreated Pyrolysis Fractions (C6, C6-C7 and C6-C8 Fractions)

Pyrolysis gasoline or distillate fractions of pyrolysis gasoline are sometimes treated with hydrogen over catalyst to saturate or partially saturate diolefins and/or olefins. In some cases, petroleum refinery streams such as a C6 reformate fraction are combined with the pyrolysis gasoline prior to this step. The hydrogenation process may be either one-stage or two-stage. The one-stage process is typically a liquid-phase process where the primary objective is to selectively convert diolefins to mono-olefins and to convert vinyl aromatics, for example, styrene to ethylbenzene. The second stage in a two-stage hydrogenation process is typically a vapor-phase, more severe hydrogenation that converts essentially all of the contained olefins to saturated hydrocarbons. A pygas fraction that will be processed by extraction or extractive distillation to produce high purity aromatics (benzene, toluene or xylenes) is subjected to two-stage hydrogenation. Pygas fractions may be forwarded to hydrodealkylation units (less common) for benzene production after one-stage of hydrogenation. Hydrotreated Pyrolysis fractions may be the result of either one- or two-stage hydrogenation.

(a) Hydrotreated C6 Fraction

This stream is very similar in composition to the Pyrolysis C6 fraction except that the non-

aromatics present in the hydrotreated stream are essentially all saturates. The reported composition for the Hydotreated C6 stream indicates typical benzene content of 75%.

(b) Hydrotreated C6-C7 Fraction

The carbon number distribution for this stream is predominantly C6 -C7 and the reported values indicate 40 to 70% benzene, and 3 to 15% toluene.

(c) Hydrotreated C6-C8 Fraction

The reported typical compositions for this stream are 40 to 60% benzene, 10 to 25% toluene and 3 to 10% C8 aromatics.

4. Quench Loop Pyrolysis Oil and Compressor Oil

Quench Loop Pyrolysis Oil (Pyoil) represents higher boiling hydrocarbons that condense in the water quench system of an ethylene plant, typically at an ethylene unit cracking ethane, propane or butane. The stream can also include liquids collected at the cracked gas compressor knock out drums, which may include compressor injection oil. The carbon number distribution for Pyoil is C4 (or even lower) through heavier hydrocarbons such as naphthalene or even heavier. The reported typical composition includes 10 to 22% benzene and 5 to11% toluene.

5. Recovered Oil from Wastewater Treatment

This stream can be expected to be of variable composition and made up largely of the components found in Pygas. No composition data or process specific information has been reported. Typically, water streams at ethylene units are processed to separate hydrocarbons from the water so that the water can be reused to generate steam for process-contact use (dilution steam for the cracking furnaces) or so that excess water can be forwarded to treatment prior to discharge or reuse. Water processing typically includes mechanical and gravity separation and steam or gas stripping. Hydrocarbons separated from the water in these systems are not usually isolated from the process. However, at least in one case, the Recovered Oil from Wastewater Treatment has been reported as an isolated intermediate.

6. Extract from Benzene Extraction

Hydrotreated pyrolysis fractions containing aromatics (most commonly benzene or benzene and toluene) are typically charged to extraction or extractive distillation units where the mixed aromatics are recovered as the Extract from Benzene Extraction. The carbon number distribution

for this steam is predominantly C6 to C8. A reported typical concentration indicates 60 to 75% benzene, 25 to 40% toluene and 0 to 1% xylenes.

III. TEST PLAN RATIONALE

A. Human Health Effects

The High Benzene Naphthas Category comprises 10 streams (complex products containing high levels of benzene [10-80%] plus many other components). All streams in this category are subject to the Occupational Safety and Health Administration (OSHA) Benzene Standard (29 CFR 1910.1028). Those streams containing 1,3-butadiene are subject to the OSHA Butadiene Standard (29 CFR 1910.1051). OSHA Permissible Exposure Limits exist for all major components. Benzene, as the predominant component in most streams, is expected to be the key driver with respect to health effects endpoints within the SIDS battery of tests, with genotoxicity and hematotoxicity the effects most likely to be seen. However, as the concentration of benzene is decreased and the concentrations of other components are increased, the observed effects of benzene are expected to diminish and the effects of other components are expected to increase.

Benzene has a robust toxicity dataset, including data on human experience, and has completed the OECD SIDS program. No further testing of benzene is needed for the HPV Chemical Challenge Program. The existing epidemiology and toxicology database for the components other than benzene and for mixtures containing the components is extensive. All components present in the streams at concentrations greater than 5% have been tested in at least one toxicity study. Those components having only limited data lack structural alerts for mammalian toxicity and data exist for their structural analogs. The C5 and C6 alkanes and alkenes present in the streams are not expected to significantly contribute to the toxicity profile as these substances are present in the streams at low concentrations and, with the exception of hexane, generally have a low level of toxicity. The toxic effects of hexane (present at $\leq$ 15%) are unlikely to be observed due to the presence of the other components, as noted below in Section III.A.1. Some data are available for one High Benzene Naphthas stream (Hydrotreated C6-C8 Fraction) and for a stream similar to the Pyrolysis Gasoline streams.

Additional data for the components, or for structural analogs of components, are under development by the American Chemistry Council Olefins Panel for other categories under the HPV program, by other HPV consortia, and by the OECD SIDS program (see Table 3). Furthermore, some of the materials being distilled out of Pyrolysis Gasoline are being tested in other Panel HPV Test Plans (Non-Cyclic C5s and Resin Oils and Cyclodiene Dimer Concentrates categories); and the High Benzene Naphthas Category shares many of the same components with the gasoline blending streams referenced in the API Petroleum HPV Gasoline Test Plan. These gasoline stream data can contribute to the hazard evaluation for the members of this category by showing effects, or lack thereof, due to mixtures containing components of this category when the benzene content is very low (~ 2%).

Hence, the basic strategy of this screening level test plan for characterizing the human health hazards of this category is to evaluate data for the components of the streams, as well as data for mixtures of

category components and analogous mixtures (existing data and data being developed by other test programs). For the HPV program, the Panel believes that the human health hazards of the category can be adequately characterized, using scientific judgment, without conducting additional toxicology tests. The Panel further believes that additional testing on streams is unlikely to demonstrate any adverse effects that have not been shown for components, and would provide little useful data for regulatory, industrial hygiene, emergency response or hazard communication purposes. Thus, no additional testing is proposed in this test plan.

Assessments of the hazards of the category members will be developed after all new data from other testing programs become available.

A discussion of chemical component interactions, specific strategies and rationales for each of the SIDS human health toxicity endpoints, and robust summaries is presented below:

1. Chemical Component Interactions

When tested as pure substances, some of the components other than benzene have caused genetic damage and adverse target organ effects in repeated-dose animal studies, as shown in Table 3. However, since the biologically active components of the High Benzene Naphthas streams are metabolized through a common P450 metabolic pathway, it is anticipated that multiple components will compete for the same active enzyme sites. Component toxicities, which are dependent on the formation of biologically active metabolites, may be reduced as less metabolite(s) will be produced through competition for these sites. Direct support for reduction or elimination of toxicities of individual components is provided by results of an existing mouse bone marrow micronucleus test with one of the High Benzene Naphthas streams, Hydrotreated C6-8 Fraction. This stream, containing approximately 55% benzene, was negative in a mouse bone marrow micronucleus test when administered by oral gavage at 5000 mg/kg to male and female CD-1 mice (see robust summary). Several studies have shown that benzene administered orally to CD-1 mice induces high frequencies of micronuclei in bone marrow erythrocytes at doses as low as 110 mg/kg (Ciranni et al., 1988; Suzuki et al., 1989; Hite et al., 1980; Gad-El Karim et al., 1986; Meyne and Legator, 1980). The presence in the Hydrotreated C6-8 Fraction of other components (approximately 25% toluene, 10% xylene, 7% pentane, 7% ethylbenzene, 3% cyclohexane, and 2% hexane) apparently inhibited the expected clastogenicity of benzene. Other similar interactions between components of the category have also been reported, as noted below.

Medinsky et al. (1994) and Bond et al. (1998) reviewed the metabolism of benzene and the effects of interactions with other organic chemicals on benzene toxicity and metabolism. Reports of interactions between other components of the High Benzene Naphthas Category have also been noted in the literature. Examples of these interactions and the effect on the formation of benzene metabolites and resultant hematotoxicity or genotoxicity are shown below:

- When benzene (440 mg/kg) and toluene (430, 860, or 1720 mg/kg) were coadministered orally to

mice, the clastogenic effect of benzene was reduced (Gad-El-Karim et al., 1984, 1986).

- Coadministration of toluene (1720 mg/kg), i.p., with benzene (440 and 880 mg/kg) to mice resulted in a reduction in the quantity of benzene metabolites measured in the urine (Andrews et al., 1977). Coexposure to toluene also protected against benzene-induced depression in ^{59}Fe utilization by red blood cells, which is used as a measure of hematotoxicity.
- Coexposure to 2000 ppm fully vaporized or light gasoline components reduced the incidence of genetic damage (micronuclei in bone marrow) resulting from a single 6-hr exposure to 40 ppm benzene (Bond et al., 1998). The major components of the fully vaporized gasoline and light gasoline mixtures, respectively, were n-butane (6.1%, 23.9%), n-pentane (3.7%, 8.4%), isopentane (12.3%, 33.5%), n-heptane (1.2%, 0.3%), toluene (8.2%, 1.1%), ethylbenzene (2.3%, 0.1%), and xylenes (8.4%, 0.2%). In these experiments, the fully vaporized gasoline mixture, which contained a higher fraction of aromatic hydrocarbons, was a more effective inhibitor of benzene metabolism than was the light fraction, which was composed primarily of aliphatic hydrocarbons.
- Results of studies with styrene-butadiene mixtures showed a decrease in the rate of metabolism of each chemical but an increase in the concentration of the circulating epoxide metabolites (Bond et al., 1998). The frequency of micronuclei seen in mice exposed by inhalation to butadiene was not altered by simultaneous exposure to styrene.
- Synergistic losses of auditory sensitivity occurred following combined exposure of rats to vapors of toluene plus n-hexane and xylene plus n-hexane (Nylen, 1996). These combined exposures, however, produced antagonistic effects in nerve conduction or action potential amplitudes in the auditory pathway, visual pathway, and peripheral nerve.
- Exposure of male rats to 1000 ppm n-hexane for 61 days caused testicular atrophy and loss of germ cell line (Nylen, 1989). Simultaneous administration of 1000 ppm toluene or xylene did not cause germ cell line alterations or testicular atrophy.
- Neurological effects have been observed in many intermediate-duration inhalation experiments in rats exposed to n-hexane (ATSDR, 1999). No neurotoxic effects were observed in a 2-year chronic study in rats and mice with commercial hexane containing 52.2% n-hexane, 16.0% 3-methylpentane, 15.6% methylchclopentane, 11.6% 2-methylpentane, 3.2% cyclohexane (Daughtrey et al., 1999). In a separate 13-week inhalation study of commercial hexane, a detailed neurobehavioral/neuropathological evaluation revealed no n-hexane-induced neuropathy (Soiefer et al., 1991).

2. Specific Strategies/Rationales for Each Endpoint

Specific strategies and rationales for each of the SIDS human health toxicity endpoints are presented below:

Acute Toxicity

There is an abundance of acute toxicity data for components present in the streams from this category at concentrations greater than 5% (see Table 3). Data is also available for one of the category streams (Hydrotreated C6-C8 Fraction) and a stream similar to the Pyrolysis Gasoline streams. Except for

dicyclopentadiene, the components have demonstrated low acute toxicity. High concentrations were needed to produce lethality via oral gavage and inhalation routes of exposure. In several studies with rats, dicyclopentadiene produced lethality at much lower doses (ranges: oral LD_{50} = 347 to 820 mg/kg, inhalation LC_{50} = 359 to >500 but < 1000 ppm). The oral LD_{50} for cyclopentadiene was 1.66 g/kg and the LD_{50}s for the other components were greater than 2 g/kg. The inhalation LC_{50}s for the components other than dicyclopentadiene ranged from 3680 to 120,000 ppm. The two streams that were tested had oral LD_{50}s greater than 2 g/kg and the one stream tested for acute inhalation toxicity had an LC_{50} greater than 12,408 ppm. Most components also have acute data for other species and routes of exposure. Thus, for purposes of the HPV Challenge Program, the available data is adequate to characterize the acute toxicity of the category members. Therefore, no additional testing for acute toxicity is proposed.

Genetic Toxicity – Gene Mutation

Of the identified category components present at concentrations greater than 5%, only 1,3-butadiene and benzene have consistently caused gene mutations in genetic toxicity tests (see Table 10). 1,3-Butadiene was positive in several *in vivo* and *in vitro* tests. Benzene was negative in several standard tests but was positive in an *in vivo* HPRT gene mutation test in mouse spleenocytes. Based on the data for components, the streams in the category are predicted to be negative in the HPV gene mutation test (Ames Test). Negative Ames Tests conducted with two streams (one from this category and one similar to category streams) support this prediction. Thus, no additional Ames Tests are proposed.

Genetic Toxicity – Chromosome Aberration

Benzene has caused chromosome aberrations in *in vitro* and *in vivo* tests. The other most prevalent component in streams in this category, toluene, is negative in both *in vitro* and *in vivo* tests. Of the remaining identified category components present at concentrations greater than 5%, only vinyl acetate, 1,3-butadiene, isoprene, hexane, and naphthalene have been reported to cause chromosome aberrations (see Table 3). As discussed above, coadministration of benzene with other hydrocarbons that are substrates for the cytochrome P450 enzymes can reduce clastogenicity, as was seen with benzene-toluene and benzene-gasoline mixtures. Further evidence for inhibition of clastogenicity is provided by results from a mouse micronucleus test with one the streams from this category, Hydrotreated C6-8 Fraction. Although the tested Hydrotreated C6-8 Fraction contained approximately 55% benzene, and benzene is positive in the mouse micronucleus test, this stream was negative. Additional information that may be useful will become available from mouse micronucleus testing that will be conducted with streams distilled from Pyrolysis Gasoline that are members of the Panel's C5 Non-Cyclics and Resin Oils and Cyclodiene Dimer Concentrates categories. Thus, based on the composition and available data for components and mixtures of components, sufficient data exist, or will become available, to allow use of scientific judgment to characterize the potential of streams in the category to cause chromosome aberrations. Thus, no additional testing for chromosome aberrations is proposed.

Subchronic Toxicity

Most of the components of the category have extensive epidemiology and toxicology databases, and most major components have been tested for chronic toxicity and carcinogenicity. In addition to the data for components, two streams were tested in repeated-dose studies. A mouse skin painting study was conducted with a stream similar to the Pyrolysis Gasoline fractions (feedstock for pyrolysis gasoline containing C5+ materials) (ExxonMobil, 1982), and a 5-day rat inhalation study was conducted with a Hydrotreated C6-8 stream. See Table 3 for a description of available data.

Repeated oral or inhalation exposures to many of the components of the streams in the category have been shown to cause adverse health effects in a variety of organs. However, existing data also show that antagonistic and synergistic interactions occur between some components comprising the streams, as noted above in Section III.A.1. The target organs affected by exposure to the mixtures, and the severity of the effects, will depend upon the relative concentrations of the components within each stream and the nature of the interactions between components.

Many of the C5 components of the High Benzene Naphthas Category are also components of the Pyrolysis C5s and Hydrotreated C5s streams (C5 Non-Cyclics Category) that will be tested for repeated-dose toxicity by the Panel, as part of the HPV Program. Based on structural similarity, pentenes are likely to have a toxicity profile similar to hexenes. The American Chemistry Council's Higher Olefins Panel will address hexenes as part of the HPV Program. Also, the International Hydrocarbon Solvents Consortium will cover the C5 aliphatic components in its C5 Aliphatics Category. Pentane will be addressed in the American Petroleum Institute's Petroleum Gases Test Plan. Other components are shared with the Panel's Resin Oils and Cyclodiene Dimer Concentrates Category streams.

Several components are sponsored in the OECD SIDS or ICCA programs (see Table 3). Additional studies with these components may be found or conducted within those programs.

Results of available data and relevant data resulting from other programs are expected to be sufficient to adequately characterize the repeated-dose human health hazard endpoints for the substances included in this category. Therefore, no additional repeated-dose testing is proposed.

Developmental Toxicity

Developmental toxicity data exist for most components present in this category at concentrations greater than 5% (see Table 3). In these studies, no convincing evidence was seen for teratogenicity in the absence of maternal toxicity. Fetotoxicity has been reported for some components, but mostly in the presence of maternal toxicity (see Table 3). Only five components (pentenes, cyclopentene, 3-methylpentane, methylcyclopentane, 1,3-cyclopentadiene) lack developmental toxicity tests. However, these components do not have structural alerts for developmental toxicity, and data being generated by other test plans within the HPV Program will provide additional information about the potential of these

substances to cause developmental effects. Three of the five materials are also components of the Pyrolysis C5s and Hydrotreated C5s streams (C5 Non-Cyclics Category) that will be tested for developmental toxicity by the Panel, as part of the HPV Program. Pentenes will be addressed by the International Hydrocarbon Solvents Consortium (C5 Aliphatics Test Plan). Also, based on structural similarity, pentenes are likely to have a developmental toxicity profile similar to hexenes. The American Chemistry Council's Higher Olefins Panel will address hexenes as part of the HPV Program. 3-Methylpentane and methylcyclopentane were components (16.0% and 15.6%, respectively) of a commercial hexane stream that was negative in a rat inhalation developmental toxicity study. A Pyrolysis Gasoline Fraction stream similar to the Pyrolysis Gasoline streams in the High Benzene Naphthas Category has been tested in an oral developmental toxicity study in rabbits. No developmental effects were seen. Additional developmental toxicity information will become available from testing conducted by the Panel for the Resin Oils and Cyclodiene Dimer Concentrates Category with streams distilled from Pyrolysis Gasoline. Thus, existing data and data that will be generated by other test programs are expected to be adequate to characterize the potential of the streams in the category to cause developmental toxicity. No further developmental toxicity tests are proposed for this endpoint.

Reproductive Toxicity

Reproductive toxicity data exist for most components present in this category at concentrations greater than 5% (see Table 3). In its review of benzene, ATSDR (1997) concluded that, although there are some data indicating adverse gonadal effects (e.g., atrophy/degeneration, decrease in spermatozoa, moderate increases in abnormal sperm forms), data on reproductive outcomes are either inconclusive or conflicting. However, most studies indicate no effects on reproductive indices, even at high doses. Reproductive organ effects were seen after inhalation exposure to isoprene and hexane. 1,3-Butadiene is sponsored in the OECD SIDS program and will be tested for reproductive toxicity. Some reproductive toxicity information exists for most major components. Many components have been tested in standard reproductive toxicity studies. Others have data from standard developmental toxicity studies. In addition, most components have data for reproductive organ toxicity, collected in repeated-dose studies. Those components lacking reproductive toxicity information do not have structural alerts for reproductive toxicity, and data being generated by other test plans within the HPV Program will provide additional information about the potential of these substances to cause reproductive effects. Some of these materials are also components of the Pyrolysis C5s and Hydrotreated C5s streams (C5 Non-Cyclics Category) that will be tested for reproductive toxicity by the Panel, as part of the HPV Program. Also, based on structural similarity, pentenes are likely to have a developmental toxicity profile similar to hexenes, which will be addressed by the American Chemistry Council's Higher Olefins Panel as part of the HPV Program. Pentenes will also be covered by the American Chemistry Council's Hydrocarbon Solvents Panel (C5 Aliphatics Test Plan). Additional reproductive toxicity information will become available from testing conducted by the Panel for the Resin Oils and Cyclodiene Dimer Concentrates Category with streams distilled from Pyrolysis Gasoline. 3-Methylpentane and methylcyclopentane were components (16.0% and 15.6%, respectively) of a commercial hexane stream that was negative in a rat inhalation two generation reproductive toxicity study. Thus, existing data and data that will be generated by other test programs are expected to be sufficient to adequately

characterize the potential for reproductive toxicity of the streams in this Category. No further reproductive toxicity tests are proposed.

3. Robust Summaries

Robust summaries for existing data for one stream from the category, Hydrotreated C6-8 Fraction, and for a stream similar to the Pyrolysis Gasoline streams (Pyrolysis Gasoline Fractions [generally C5-C10 but primarily C5-C7: Pyrolysis Gasoline, Rerun Tower Overheads]), are provided with this test plan. Robust summaries for data being developed by other groups for HPV, OECD SIDS, and ICCA high production volume testing programs will be provided when they become available through those programs. Most existing data for components of the category have been extensively reviewed in the literature as noted in Table 3, obviating the need for robust summaries.

B. Physical-Chemical Properties

The physicochemical (PC) endpoints in the HPV Chemical Program include:

- Melting Point
- Boiling Point
- Vapor Pressure
- Water Solubility
- Octanol/Water Partition Coefficient (K_{ow})

Calculated PC data for selected component chemicals in this category will be developed using a computer model to provide a consistent, representative data set. In addition, measured PC data will be identified for selected products in this category and will be summarized together with the calculated data to provide comparisons between the two data sets. The selection of component chemicals to be modeled will be made once an appropriate measured data set is identified.

Calculated PC data for selected component chemicals in the High Benzene Naphthas Category will be developed using the EPIWIN© computer model (EPIWIN, 1999), as discussed in the US EPA document entitled *The Use of Structure-Activity Relationships (SAR) in the High Production Volume Chemicals Challenge Program* (USEPA, 1999a). The use of computer modeling for the development of these data is appropriate since components of the streams in this category are all chemically related and are expected to exhibit relatively similar environmental properties. In addition, for all the chemicals selected to represent products in this category, a calculated dataset provides a common method in the development of these values.

Boiling point, melting point, and vapor pressure ranges will be determined using the MPBPVP subroutine in EPIWIN. K_{ow} and water solubility will be calculated using KOWIN and WSKOW subroutines, respectively. There is more information on calculating data for the HPV chemical program in the EPA document titled '*The Use of Structure-Activity Relationships (SAR) in the High*

Production Volume Chemicals Challenge Program" (U.S. EPA, 1999a).

Because the HPV substances covered under the High Benzene Naphthas Category testing plan are mixtures containing differing compositions, it is not possible to develop or calculate a single numerical value for each of the physicochemical properties. For example, a product that is a mixture of chemicals does not have boiling point, but rather a boiling range. Calculated values for physicochemical properties will be represented as a range of values according to the product's component composition and based on the results of computer modeling. Robust summaries characterizing the PC endpoints will be prepared upon completion of a review of available measured data, and will include the calculated and measured data.

C. Environmental Fate

The environmental fate endpoints in the HPV Chemical Challenge Program include:

- Biodegradation
- Photodegradation
- Hydrolysis
- Fugacity

Although biodegradation data are not available for products in the High Benzene Naphthas Category, there are data for selected component chemicals of those products, as well as for complex products, that can be used to characterize the potential biodegradability of products in this category. The complex product values are for substances composed of a range of chemicals with regard to carbon numbers and chemical classes (i.e., paraffins, alkenes or alkylbenzenes). As suggested by the experimental data, products in this category will exhibit a high extent of biodegradation.

Data or information for the fate endpoints, photodegradation and hydrolysis, will be developed and either will be calculated and/or discussed in technical summaries. Chemicals in this category are not subject to hydrolysis at measurable rates, therefore information for this endpoint will be summarized in a technical review document.

Equilibrium models are used to calculate chemical fugacity, which can provide information on where a chemical is likely to partition in the environment. These data are useful in identifying environmental compartments that could potentially receive a released chemical. Fugacity data can be calculated only for individual chemicals. For the HPV Chemical Challenge Program, environmental partitioning data will be developed for selected component chemicals of the products in this category.

A preliminary evaluation of chemicals in the High Benzene Naphthas Category suggests that they will partition largely to the air, and therefore their fate in air is of environmental interest. Because the air phase may be a compartment that could potentially receive many of the component chemicals in this category, data characterizing their potential for physical degradation in the atmosphere will be

developed (this is discussed below under photodegradation).

1. Biodegradation

There are sufficient data to characterize the potential biodegradability of products in this category. Data for constituent chemicals of products in this category (as well as for complex products not in this category that contain chemicals found in products from this category) suggest that high benzene naphthas products have the potential to biodegrade to a great extent (Table 4). The carbon number of products in this category ranges primarily between C5 to C11. Results for several chemicals, including benzene, with carbon numbers in this range that are contained by these products have been shown to biodegrade from 63 to 100% after 14 or 28 days, while results for several comparable, complex products containing several components range from 21 to 96% after 28 days. As seen by the data in Table 4, there is a relatively large biodegradation database for single chemicals and complex products that can be used to characterize this endpoint for high benzene naphthas products. Because products in this category are compositionally more comparable to the products identified in Table 4 as gasoline streams, these data best describe the potential biodegradability of the high benzene naphtha products. Gasoline stream compositions are provided in Table 5.

The data from the majority of tests in Table 4 were developed using a manometric respirometry test procedure. This procedure uses continuously stirred, closed systems, which is recommended when assessing the potential biodegradability of chemically complex, poorly water soluble, and volatile materials like those in this category. Stirring is recommended when evaluating products containing several chemicals, some of which may have limited water solubility.

2. Photodegradation – Photolysis

Direct photochemical degradation occurs through the absorbance of solar radiation by a chemical substance. If the absorbed energy is high enough, then the resultant excited state of the chemical may lead to its transformation. Simple chemical structures can be examined to determine whether a chemical has the potential for direct photolysis in water. First order reaction rates can be calculated for some chemicals that have a potential for direct photolysis using the procedures of Zepp and Cline (1977).

To develop information or data that will characterize the potential of products in this category to undergo direct photochemical degradation, the existing product chemical composition data will be evaluated to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. The UV light absorption of selected chemicals in products in the High Benzene Naphthas Category will be evaluated to identify those chemicals with a potential to degrade in solution. When possible, first order reaction rates will be calculated for chemicals identified to have a potential for direct photolysis in water. The results of the calculations will be summarized in a technical discussion for this endpoint. If instead, a low potential for direct photolysis is suggested by the evaluation, a technical discussion will be prepared to summarize the findings.

3. Photodegradation – Atmospheric Oxidation

Photodegradation can be measured (U.S. EPA, 1999b) (the US EPA identifies OECD test guideline 113 as a test method) or estimated using models accepted by the US EPA (U.S. EPA, 1999a). An estimation method accepted by the US EPA includes the calculation of atmospheric oxidation potential (AOP). Atmospheric oxidation as a result of hydroxyl radical attack is not direct photochemical degradation, but rather indirect degradation. AOPs can be calculated using a computer model. Hydrocarbons, such as those in the High Benzene Naphthas Category, have the potential to volatilize to air where they can react with hydroxyl radicals (OH-).

The computer program AOPWIN (atmospheric oxidation program for Microsoft Windows) (EPIWIN, 1999) is used by the US EPA OPPTS (Office of Pollution Prevention and Toxic Substances). This program calculates a chemical half-life based on an overall OH- reaction rate constant, a 12-hr day, and a given OH- concentration. This calculation will be performed for representative chemical components of products in the High Benzene Naphthas Category. The existing product chemical composition data will be evaluated to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. The resulting calculations will be summarized in a robust summary for this endpoint.

4. Hydrolysis

Hydrolysis of an organic chemical is the transformation process in which a water molecule or hydroxide ion reacts to form a new carbon-oxygen bond. Chemicals that have a potential to hydrolyze include alkyl halides, amides, carbamates, carboxylic acid esters and lactones, epoxides, phosphate esters, and sulfonic acid esters (Neely, 1985).

Chemical stability in water can be measured (EPA identifies OECD test guideline 111 as a test method) or estimated using models accepted by the EPA (U.S. EPA, 1999b). An estimation method accepted by the EPA includes a model that can calculate hydrolysis rate constants for esters, carbamates, epoxides, halomethanes, and selected alkylhalides. The computer program HYDROWIN (aqueous hydrolysis rate program for Microsoft windows) (EPIWIN, 1999) is used for this purpose by OPPTS.

However, all of the chemical structures included in the High Benzene Naphthas Category are hydrocarbons. That is, they consist entirely of carbon and hydrogen. As such they are not expected to hydrolyze at a measurable rate. A technical document will be prepared that discusses the potential hydrolysis rates of these substances, the nature of the chemical bonds present, and the potential reactivity of this class of chemicals with water.

5. Chemical Transport and Distribution in the Environment - Fugacity Modeling

Fugacity based multimedia modeling can provide basic information on the relative distribution of chemicals between selected environmental compartments (i.e., air, soil, sediment, suspended sediment, water, biota). The US EPA has acknowledged that computer modeling techniques are an appropriate approach to estimating chemical partitioning (fugacity is a calculated endpoint and is not measured). A widely used fugacity model is the EQC (Equilibrium Criterion) model (Mackay et al., 1996). The U.S. EPA cites the use of this model in its document titled "*Determining the Adequacy of Existing Data*" U.S. EPA, 1999b), which was prepared as guidance for the HPV Chemical Program.

In its document, U.S. EPA states that it accepts Level I fugacity data as an estimate of chemical distribution values. The input data required to run a Level I model include basic physicochemical parameters; distribution is calculated as percent of chemical partitioned to 6 compartments described above within a defined unit world. Level I data are basic partitioning data that allow for comparisons between chemicals and indicate the compartment(s) to which a chemical is likely to partition.

The EQC Level I is a steady state, equilibrium model that utilizes the input of basic chemical properties including molecular weight, melting point, vapor pressure, and water solubility to calculate distribution within a unit world. This model will be used to calculate distribution values for representative chemical components identified in products from this category. Existing product chemical composition data will be evaluated to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. A computer model, EPIWIN version 3.04 (EPIWIN, 1999), will be used to calculate the physicochemical properties needed to run the Level I EQC model.

D. Aquatic Toxicity

The aquatic toxicity endpoints for the HPV Chemical Program include:

- Acute Toxicity to a Freshwater Fish
- Acute Toxicity to a Freshwater Invertebrate
- Toxicity to a Freshwater Alga

Although aquatic toxicity data are not available for products in the High Benzene Naphthas Category, there are sufficient read across data from both constituent chemicals of those products and complex products to fully characterize the toxicity of this category. The use of data from selected read across materials to products in this category can be justified for the following reasons:

- Individual chemicals and complex products used for read across purposes contain a chemical class or combinations of chemical classes (i.e., olefins, aromatics, paraffins) that are found in products from this category.
- Individual chemicals and complex products used for read across purposes have a carbon

number or carbon number range that falls within the range of carbon numbers found in products from this category.

- Individual chemicals and complex products used for read across purposes as well as the products in this category are composed of chemicals that act by a similar mode of toxic action.

The data in Table 6 provides a comparison of the range of product compositions (i.e., carbon number, chemical class, weight percent) in the High Benzene Naphthas Category to materials used to characterize the aquatic toxicity of this category. This comparison illustrates the similarity in carbon number ranges between products in this category and the selected products with read across data. The data in Tables 7, 8, and 9 establish the range of toxicity that products in this category are expected to demonstrate, based on the read across data.

The aquatic toxicity data presented in this test plan fall within a narrow range of values regardless of their varying chemical class content and carbon number range. This is not unexpected, because the constituent chemicals of products in this category are neutral organic hydrocarbons whose toxic mode of action is non-polar narcosis. The mechanism of short-term toxicity for these chemicals is disruption of biological membrane function (Van Wezel and Opperhuizen, 1995), and the differences between measured toxicities (i.e., LC/LL50, EC/EL50) can be explained by the differences between the target tissue-partitioning behavior of the individual chemicals (Verbruggen et al., 2000).

The existing fish toxicity database for narcotic chemicals supports a critical body residue (CBR, the internal concentration that causes mortality) of between approximately 2-8 mmol/kg fish (wet weight) (McCarty and Mackay, 1993; McCarty et al., 1991), supporting the assessment that these chemicals have equal potencies. When normalized to lipid content, the CBR is approximately 50 umol of hydrocarbon/g of lipid for most organisms (Di Toro et al., 2000). Because the products in this category are all complex mixtures containing relatively similar series of homologous chemicals, their short-term toxicities are expected to fall within the range of toxicity demonstrated by the individual chemicals, as well as comparable products summarized in this test plan. Therefore, the existing data are believed to form a sufficiently robust dataset to fully characterize the aquatic toxicity endpoints in the HPV Chemical Program for this category.

The fish and invertebrate acute and alga toxicity values for individual chemicals and complex products similar to those in this category (Tables 7, 8, 9) fall within a range of approximately 1-64 mg/L and overlap between the three trophic levels. Because the products in the High Benzene Naphthas Category will range in paraffin, alkene, and/or aromatic carbon number content within approximately C5 to C11, a range in toxicity for products in this category will be comparable to the range of data summarized in Tables 7, 8, and 9.

As suggested by the experimental data, this category will exhibit a moderate range of acute toxicity to fish and invertebrates and a moderate range of toxicity to algae. For representative chemicals and products, experimental acute fish toxicity values range between 2.5 to 46 mg/L for two species (Table

7), while acute invertebrate toxicity values range between 0.9 to 32 mg/L for one species (Table 8). In comparison, alga toxicity values for one species range between 1.0 to 64 mg/L (for biomass and growth rate endpoints), while alga NOELR values range between 1.0 to 51 mg/L (for biomass or growth rate endpoints) (Table 9).

IV. TEST PLAN SUMMARY

Based upon examinations of stream compositions and existing toxicity data for components of streams in the category, there is minimal likelihood for the appearance of unexpected or remarkable biological findings in testing of these streams. All streams in this category are subject to the Occupational Safety and Health Administration (OSHA) Benzene Standard (29 CFR 1910.1028). Those streams containing 1,3-butadiene are subject to the OSHA Butadiene Standard (29 CFR 1910.1051). OSHA Permissible Exposure Limits exist for all major components. Hence, the basic strategy of this screening level test plan for characterizing the human health hazards of this category is to evaluate data for the components of the streams, as well as data for mixtures of category components and analogous mixtures (existing data and data being developed by other test programs). Benzene, as the predominant component in most streams, is expected to be the key driver with respect to health effects that would be observed in the SIDS battery of tests, with genotoxicity and hematotoxicity the effects most likely to be seen. However, as the concentration of benzene is decreased and the concentrations of other components are increased, the observed effects of benzene are expected to diminish and the effects of other components are expected to increase. Benzene has a robust toxicity dataset and has completed the OECD SIDS program. No further testing of benzene is needed for the HPV Chemical Challenge Program. The other major chemical components of streams in the High Benzene Naphthas Category have been extensively and comprehensively tested for human health toxicity endpoints, and all components present in the streams at concentrations greater than 5% have been tested in at least one toxicity study. Those components having only limited data lack structural alerts for mammalian toxicity and data exist for structural analogs. Some data are available for one High Benzene Naphthas stream [Hydrotreated C6-C8 Fraction] and a stream similar to the Pyrolysis Gasoline streams. Some data are also available regarding interactions between certain components that impact metabolism and toxicity. Additional supporting data for components of the High Benzene Naphthas streams, tested either individually or as components of other streams or mixtures, will be collected by other test plans within the Olefins Panel's HPV program, by other consortia participating in the HPV or ICCA programs, or from chemicals sponsored in the OECD SIDS program. These data are expected to provide sufficient information to develop scientific judgment-based characterizations of the human health effects of streams in this category. Therefore, no additional human health toxicity testing is proposed.

Data will be developed and/or identified to adequately characterize relevant physicochemical endpoints in the HPV Chemical Challenge Program.

Biodegradation data identified as read across data to the High Benzene Naphthas Category show that products in this category have the potential to exhibit a high extent of biodegradability. The existing read

across data provide sufficient information to adequately characterize the biodegradability of products in this category. Therefore, no additional biodegradation testing is proposed.

The chemical components in these products are relatively volatile, and if released they would be expected to partition to the air phase to a significant extent. In the air, they are subject to rapid physical degradation through hydroxyl radical attack. Therefore, as a result of both biological and physical degradation processes, these products are not expected to persist in the environment.

Sufficient information has not been developed on the potential of products in this category to photodegrade, hydrolyze, and partition within the environment. Therefore, information or data will be developed to adequately characterize these endpoints.

Read across aquatic toxicity data show that products in the High Benzene Naphthas Category have the potential to produce a moderate level of toxicity in freshwater algae and acute toxicity in freshwater fish and invertebrates. The existing read across data provide sufficient information to adequately characterize the aquatic toxicity of products in this category. Therefore, no additional toxicity testing is proposed.

The evaluations, modeling, and technical discussions that will be developed for the High Benzene Naphthas Category are summarized in Table 10.

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Table 1.
CAS Numbers and Descriptions Associated with Streams in the High Benzene Naphthas Category

CAS Number	CAS Number Description
64741-99-7	Extracts, petroleum, light naphtha solvent
64742-49-0	Naphtha, petroleum, hydrotreated light
64742-73-0	Naphtha, petroleum, hydrodesulfurized light
64742-83-2	Naphtha, petroleum, light steam-cracked
64742-91-2	Distillates, petroleum, steam-cracked
67891-79-6	Distillates, petroleum, heavy arom.
67891-80-9	Distillates, petroleum, light arom.
68410-97-9	Distillates, petroleum, light distillate hydrotreating process, low-boiling
68475-70-7	Aromatic hydrocarbons, C6-8, naphtha-raffinate pyrolyzate-derived
68476-45-9	Hydrocarbons, C5-10 arom. conc., ethylene-manuf.-by-product
68526-77-2	Aromatic hydrocarbons, ethane cracking scrubber effluent and flare drum
68606-10-0	Gasoline, pyrolysis, debutanizer bottoms
68606-28-0	Hydrocarbons, C5 and C10-aliph. and C6-8-arom.
68921-67-5	Hydrocarbons, ethylene-manuf.-by-product distn. residues
68955-29-3	Distillates, petroleum, light thermal cracked, debutanized arom.
68956-52-5	Hydrocarbons, C4-8
68956-70-7	Petroleum products, C5-12, reclaimed, wastewater treatment
69013-21-4	Fuel oil, pyrolysis
8030-30-6	Naphtha

Note: The definitions, found in the TSCA Chemical Substance Inventory, for the CAS numbers included in this group are vague with respect to composition. Therefore, it is not uncommon to find that the same CAS number is correctly used to describe different streams (compositions) or that two or more different CAS numbers are used to describe the same stream (composition).

Table 2.
Typical Composition Ranges (Percent) for High Benzene Naphthas
(See notes 1-4 at the end of this table)

Component	Pyrolysis Gasoline	Quench Loop Pyrolysis Oil Wastewater Treatment (see Note 4)	Pyrolysis C6 Fraction	Pyrolysis C6-C8 Fraction	Pyrolysis C5-C6 Fraction	Hydrotreated C6-C7 Fraction	Hydrotreated C6-C8 Fraction	Hydrotreated C6 Fraction	Extract from Benzene Unit
Vinyl Acetate	9.9								
1,3-Butadiene	6.7		0.1 - 2						
C4's	0.5 -5		0.1 - 1.5						
1,4-Pentadiene	0.3 - 0.9		0.1 - 2						
Isopentane (2-methylbutane)	2.0		0.1 - 1						
1-Pentene (Amylene)	0.6 - 4		1 - 3						
2-Methyl-1-Butene	1.0								
Pentene-2 (isomer mix)	0.2 - 1.8		0.1 - 5						
Isoprene (2-methylbutadiene-1,3)	0.6 -10		2 - 6		6				
Pentenes					10				
Pentane	10					1			
2-Methyl-2-Butene	1.2		2						
Other C5's	0.3						2.0		
3-methyl-1,2-butadiene			1 - 3						
1,3-Cyclopentadiene	1 - 20		0.1 - 5	1					
1,3-Pentadiene (isomer mix)	0.7 - 4.4		0.3 - 4						
Cyclopentene	0.6 - 5				8				
Cyclopentane	2.3					1 - 5		4	
1,5-hexadiene	0.6								
2-methylpentane	4							4	
2-methyl-1-Pentene	0 - 2.2								
3-methylpentane (Isohexane)	1.3					10 - 20		4	
hexene-1	0 - 2.2								
hexenes						2			
Methylcyclopentadiene	5			1					
Hexane isomers				1 - 3		5 - 20			
Hexane	0 – 9			1 - 5		2 - 15		6	
Methylcyclopentane	4.9					5 - 15			
1-methylcyclopentene	0.1 -								

Component	Pyrolysis Gasoline	Quench Loop Pyrolysis Oil	Wastewater Treatment (see Note 4)	Pyrolysis C6 Fraction	Pyrolysis C6-C8 Fraction	Pyrolysis C5-C6 Fraction	Hydrotreated C6-C7 Fraction	Hydrotreated C6-C8 Fraction	Hydrotreated C6 Fraction	Extract from Benzene Unit
	2.4									
C6 non-aromatics		0.9		30						
non-Aromatic Hydrocarbons								20 - 26		
Benzene	15 - 62	10 - 21.6		35 - 77	30 - 80	70	40 - 69	40 - 60	75 - 75.7	60 - 75
1,3-cyclohexadiene	0.5 - 2.0									
Cyclohexane	2						1 - 3		6	
Cyclohexene	0.6									
cyclohexadienes	0.1 - 2.3									
3-ethylpentene-1				1						
C6 olefin	0.2 - 1.9									
heptenes							2			
2-methylhexane							2			
heptane isomers							1 - 5			
Heptane	0.4 -2				1		1 - 5			
C7 Paraffins & Napththenes	0.3 - 1.1									
C7 Olefins	0 - 1.2									
Methylcyclohexane							1 - 3			
C7-Non-aromatics		2.2		3						
Toluene	17.4	5 – 10.9		0.5 - 5	15 - 25	5	3 - 15	10 - 25	0.3	25 - 40
4-Vinlyclohexene (Butadiene Dimer)	0.1 - 1									
C8 Nonaromatics		1.3								
Ethylbenzene	0.3 - 5.5	1 – 3		1	1 - 3					
C8 Aromatics								3 - 10		1
Xylenes, mixed	10	1.5			1 - 10					
Styrene	10	10 – 15			1 - 10					
C9 Aromatics	0.4 - 1.7									
Ethyltoluenes	0.1 – 2									
C9 Paraffins and Naphthenes	0.3 - 1.3									

Component	Pyrolysis Gasoline	Quench Loop Pyrolysis Oil Wastewater Treatment (see Note 4)	Pyrolysis C6 Fraction	Pyrolysis C6-C8 Fraction	Pyrolysis C5-C6 Fraction	Hydrotreated C6-C7 Fraction	Hydrotreated C6-C8 Fraction	Hydrotreated C6 Fraction	Extract from Benzene Unit
1,3,5-Trimethylbenzene (mesitylene)	3								
C10+		40.6							
1,2,4-Trimethylbenzene (pseudocumene)	0 - 3.3			1					
4-methylstyrene	0 - 3.3								
Cyclopentadiene/Methyl cyclopentadiene Codimers	0.9 - 4.4			1 - 3					
Dicyclopentadiene	20	3.7		1 - 5					
1-Decene	1.5								
Vinyl Toluene	0.1 - 1.1								
dihydrodicyclopentadiene	2								
Decane	0.1 - 5								
C10 Aromatics	1.6								
C10's		1.6 - 27							
Indene	0.6 - 5								
C11+		38.8 - 50							
Naphthalene	15.0	4.3 - 10							
Methylnaphthalene	2.9								
1-Methylnaphthalene	1								
1,1'-Biphenyl	0.1 - 0.9								
C10 Olefins	1.2								

Note 1: The composition data shown above are composites of reported values.
Note 2: The balance of these streams is expected to be other hydrocarbons that have boiling points in the range of the listed components.
Note 3: The listed highs and lows should not be considered absolute values for these limits. They are instead the highs and lows of the reported values.
Note 4: No specific composition data are available. This stream is expected to contain components of Pyrolysis Gasoline.

Table 3. Summary Results from Existing Human Health Effects Data for Chemical Components and Streams of High Benzene Naphthas Category

(Note: This table is the product of a good faith effort to briefly summarize results of toxicity studies that were available to the reviewer for SIDS endpoints. Results from non-SIDS endpoints are not included. Since all information for a particular chemical may not have been available to the reviewer, the results presented should not be considered as final assessments of the hazards of the listed chemicals. Component data were not reviewed for data adequacy. Robust summaries for the listed components will not be submitted with the Test Plan.)

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Vinyl Acetate	Oral LD50 = 2.9 g/kg; inhalation LC50 = 3680 ppm [4h]	Negative in Ames Test	Positive in mouse bone marrow micronucleus test by i.p. but negative in rats and mice by inhalation and oral; positive in in-vitro chrom ab	4 and 13-wk rat and mouse inhalation study: decrease in BW gain, respiratory tract effects; no clearly treatment related effects in 4 and 13-wk rat and mouse oral	In rat inhalation study, no embryolethality or teratogenicity seen; fetal growth retardation seen at maternally toxic doses. In rat oral study, no effects.	In an oral rat 2-gen repro study, no effects were seen except for reduction in BW gain in high-dose F1 pups.		Review: IRIS[1] – 1990; HSDB[2]; ATSDR – 1992[4]

[1] IRIS: EPA Integrated Risk Information System
[2] HSDB: Hazardous Substances Data Bank [TOMES, MICROMEDEX, Inc.]

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
1,3-Butadiene	Rat inhalation LC50[4h] = 129,000 ppm	Negative in UDS in mouse and rat, Drosophila; negative and positive in mouse lymphoma; positive in Ames, CHO and in vivo mouse spleenocyte HPRT tests and mouse spot test	Positive in mouse dominant lethal but negative in rat; positive in mouse bone marrow micronucleus and chrom. ab.; negative in rat bone marrow micronucleus	Many studies: Toxicity to blood cells in mice; no effects in rats [inhalation]	Effects seen at maternally toxic doses	Will become available through OECD SIDS	Olefins Panel's Crude Butadiene C4 Category, OECD SIDS	Reviews: ECETOC Special Report No. 12 - 1997[3]; ATSDR[4] - 1993
Isoprene (2-methylbutadiene-1,3)	Rat oral LD50= 2.1 g/kg; inhalation LC50 [4h] = 64,500 ppm	Negative in Ames Test	Negative in in-vitro CHO chrom. ab., mouse bone marrow chrom. ab. and rat lung cell micronucleus [inhalation]; positive in mouse bone marrow micronucleus [inhalation]	Many studies: Effect on testes in rats seen at 26 wks but not at 13 wks; effects on blood cells, nasal epithelium, liver, stomach, and testes in mice [inhalation]	No effects in rats; fetotoxicity in mice	Limited repro tox data [sperm motility, vaginal cytology, histopath of repro organs]obtained as part of 13-wk inhalation study: [slight effect on testis in rats; effects on testes, epididymus, sperm, estrus cycle in mice]	Olefins Panel's C5 Non-Cyclics Category/ICCA	Review: IARC[5] - 1999

[3] ECETOC: European Centre for Ecotoxicology and Toxicology of Chemicals
[4] ATSDR: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry
[5] IARC: International Agency for Research on Cancer

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Pentenes				2-pentene: 4 wk rat oral evaluating nephrotoxicity showed no kidney lesions at 2 g/kg/day w/60% mortality			International Hydrocarbon Solvents Consortium [C5 Aliphatics Category Test Plan]; also, pentenes are likely to have a toxicity profile similar to hexenes which will be addresed by the Higher Olefins Panel	Halder et al., 1985

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Pentane	Rat oral: LD50>2 g/kg; inhalation LC50[4h] >7000 ppm	Negative in Ames Test	Negative in rat bone marrow micronucleus [inhalation] and dominant lethal [i.p.]; positive [not reproducible] in in-vitro CHO chrom.ab.	90-day rat inhalation: no effect at ~ 7000ppm. 16 wk and 7-30 wk rat inhalation neurotox evaluations : negative With 50/50 blend of n-butane and n-pentane, in a 90-day rat inhalation study with scope limited to evaluation of nephrotoxicity: decrease in BW and male hydrocarbon nephropathy.	No effect in rat oral	No effect on repro organs in 90-day rat inhalation	API [addressed in Petroleum Gases Test Plan]; International Hydrocarbon Solvents Consortium [C5 Aliphatic Category Test Plan]; OECD SIDS	Review: McKee et al., 1998; Galvin and Marashi, 1999

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
1,3-Cyclopentadiene	Rat oral: 4/5 died at 1 g/kg; inhalation LC50 [4h] = 39 mg/L			Mild liver and kidney effects in rats after 35 exp. of 500 ppm ; no effects in guinea pigs, rabbits, dogs after 135 exp. of 250 ppm, or in dogs after 39 additional exp of 400 ppm and 16 additional exp of 800 ppm [inhalation]				ACGIH[6], RTECS[7], EPA Documents [86960000024, 86960000121S
Cyclopentene	Rat oral LD50 = 1.66 g/kg; inhalation LCLo [4h] = 16,000 ppm							RTECS
3-methylpentane (Isohexane)				16 wk and 7-30 wk rat inhalation neurotox evaluations : negative				Frontali et al., 1981

[6] ACGIH: American Conference of Governmental Industrial Hygienists
[7] RTECS: Registry of Toxic Effects of Chemical Substances

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Hexane isomers [Commercial Hexane tested: 52.2% n-hexane, 16.0% 3-methylpentane, 15.6% methylcyclopentane, 11.6% 2-methylpentane, 3.2% cyclohexane]		Negative in Ames Test, CHO HPRT	Negative in in-vitro CHO chrom. ab. and rat bone marrow chrom. ab. [inhalation]	No neurotoxicity; male rat hydrocarbon nephropathy [inhalation]	No effects in rats via inhalation	No effect in rat 2-gen study via inhalation except decrease in weight gain in high dose offspring		Daughtrey et al., 1994 a,b; 1999; Kirwin et al., 1991
Hexane	Rat oral LD50=28.7 g/kg; inhalation LC50[4h] = 48,000 ppm	Negative in Ames Test and in vitro UDS	Negative in in-vitro CHO chrom. ab. , inhalation dominant lethal and mouse micronucleus [inhalation and IP]; positive in rat oral bone marrow chrom. ab.	Several studies: Effects on peripheral nervous system and testes	Negative in inhalation and oral developmental studies	No repro tox studies found; testicular atrophy seen in subchronic inhalation studies	OECD SIDS - ICCA	Review: ATSDR[8] – 1999; rat chrom. ab. report in HSDB[9]
Methylcyclopentane				4 wk rat oral evaluating nephrotoxicity showed no kidney lesions at 0.5 g/kg/day but lesions at 2g/kg w/40%mortality				Halder et al., 1985

[8] ATSDR: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry
[9] HSDB: Hazardous Substances Data Bank [TOMES, MICROMEDEX, Inc]

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Benzene	Rat oral LD50=810 mg/kg; inhalation LC50 [4h] = 13,700 ppm	Negative in Ames Test, mouse lymphoma, CHO HPRT, in-vitro UDS, Drosophila; positive in mouse spleen HPRT	Positive in vitro/in vivo in numerous studies and species [oral, inhalation]: in-vitro human lymphocytes; chrom. ab. and micronucleus in mouse bone marrow and spleen lymphocytes; rat bone marrow chrom. ab. and micronucleus	Many studies: Primary effect toxicity to blood cells	Several studies: fetotoxic at maternally toxic doses; not tetratogenic	No standard repro studies; most inhalation studies with repro parameters indicate no effect on reproductive indices, even at high doses	OECD SIDS	Review: ATSDR – 1997; EU Risk Assessment – 2001 [Draft]
Cyclohexane	Rat oral LD50 > 5 g/kg; inhalation LC50[4h] = 4044 ppm	Negative in Ames Test, mouse lymphoma, human lymphocyte UDS	Negative in rat bone marrow chrom. ab. [inhalation]	Effects on liver in mice and rats; on liver and kidney in rabbits [inhalation]	No effects seen in rats or rabbits [inhalation]	No effects in rat 2-gen inhalationrepro at doses not maternally toxic	OECD SIDS	Review: SRC Technical Support Document #TR-86-030 [Beals et al.,1986, draft][10]; EU Risk Assessment – 2000 [Draft] Bamberger, 1996; Kreckman, 1997; Malley, 1996 a,b

[10] SRC: Syracuse Research Corporation Center for Chemical Hazard Assessment, prepared for Test Rules Development Branch, Existing Chemical Assessment Division, Office of Toxic Substances

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Toluene	Rat oral LD50 = 5.5 – 7.53 g/kg; inhalation LC50[4h] = 8000 - 8800 ppm	Negative in Ames Test, SHE transformation, and Drosophila SLRL; equivocal in mouse lymphoma	Negative in in-vitro human lymphocyte and CHO chrom. ab., dominant lethal [oral], chrom. ab. in mice [oral] and rats [inhalation], and mouse micronucleus [oral]	Many studies: Effects on central nervous system; hearing loss in rats	In rats and mice: lower birth weight, delayed postnatal development and behavioral effects [inhalation]	No effects in mouse 2-gen inhalation repro study; in rats, effect on sperm count and epididymal weight at 2000 ppm, but no effect on fertility	OECD SIDS	Review: ATSDR[11] – 2000; IARC[12] – 1999; EU Risk Assessment - 2001 Genetic toxicity review: McGregor, 1994.
Ethylbenzene	Rat oral LD50> 3.5 g/kg; inhalation LC50[4h] LC50 = 4000 ppm	Negative in Ames Test, Drosophila SLRL, and in-vivo UDS in mouse hepatocytes; equivocal in mouse lymphoma	Negative in in-vitro CHO and RL4 cells chrom. ab. and in inhalation/i.p. mouse micronucleus	Several studies: Effects seen in liver, kidney, and lung in rats and mice; hearing loss in rats via inhalation	No effects in rabbits; only supernumerary ribs seen in rats	No repro study; in subchronic rat and mouse studies, no effects seen in gonads sperm, extrus cycle	OECD SIDS	Review: ATSDR[13] - 1999
Xylenes, mixed	Rat oral LD50 = 3.5-8.6 g/kg;Rat inhalation [4h]LC50 = 6,350 - 6,700 ppm	Negative Ames Test and mouse lymphoma	Negative in human lymphocytes [only w/o S9 tested] and CHO chrom. ab.	Many studies: liver, and nervous system effects via inhalation; hearing loss in rats via inhalation; nervous system effects via oral exposure	Fetotoxic effects seen in rat and mouse [oral,inhalation], mostly secondary to maternal toxicity	Negative in rat repro [exposed by inhalation 131 days prior to mating, during mating, gestation, day 5-20 of lactation]; no effect on repro organs in rat and mouse	ACC Toluene Xylene Panel/OECD SIDS/ICCA	Review: ATSDR – 1995; WHO EHC - 1997[14]; ECETOC - 1986

[11] ATSDR: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry
[12] IARC: International Agency for Research on Cancer
[13] ATSDR: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry
[14] WHO EHC: World Health Organization, International Programme on Chemical Safety. Environmental Health Criteria

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Styrene	Rat oral LD50 $\geq$ 5 g/kg; inhalation LC50 [4h] = 4940 ppm	Inconsistent results in Ames Test	Inconsistent results in in-vitro chrom. ab. tests; negative in chrom. ab. and micronucleus tests in mice and rats by oral and inhalation exposure	Many studies: Effects on liver in rats [oral, inhalation] and mice [inhalation]; hearing loss in rats [inhalation]; respiratory tract in rats [inhalation]; lungs in mice [oral]	No birth defects in rats [oral, inhalation] or in mice, rabbits and hamsters [inhalation]; other effects seen only at maternally toxic doses	Negative in rat 3 gen repro study [oral]	OECD SIDS	Reviews: ATSDR – 1992; IARC[15] – 1994 Brown, 1991, 1993 [repro/devel]
Dicyclopentadiene	Rat oral LD50 ranged from 347 – 820 mg/kg; inhalation LC50[4h] ranged from 359 to 500-1000 ppm	Negative in Ames Test	Negative in in-vitro CHO and CHL chrom. ab.	Many studies: Most studies showed no effects in rats or mice in dietary or inhalation studies except male rat hydrocarbon nephropathy in inhalation studies	No effect in rats in oral [diet] studies	Effects only at maternally toxic doses in rat 3-gen repro study [in diet]	OECD SIDS	Review: ECETOC[16] – 1991 JETOC[17] Issue 3 No. 32, 1998 [CHL chrom. ab and OECD 422 studies]; NTP[18] [CHO chrom. ab.]

[15] IARC: International Agency for Research on Cancer
[16] ECETOC: European Centre for Ecotoxicology and Toxicology of Chemicals
[17] JETOC: Japanese Chemical Industry Ecology – Toxicology and Information Center
[18] NTP: National Toxicology Program – personal communication

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Naphthalene	Rat oral LD50 ranged from 2200 to 2600 mg/kg; no effect at 78 ppm [4h] inhalation	Negative in Ames Test, transformation, in-vivo UDS in rat liver	Negative in mouse micronucleus; positive in in-vitro CHO chrom. ab.	Many studies: Toxicity to blood cells in dogs [hemolytic anemia][oral]but not rats or mice; cataracts in rabbits, rats, mice, guinea pigs [oral]; local irritative effects after inhalation in rats and mice	No birth defects in rabbits, rats, and mice [oral]; reduced litter size in mice at maternally toxic doses [oral on gestation day 7-14]; no effect in rabbits exposed orally on gestation days 6-18		OECD SIDS	Reviews: ATSDR[19] – 1995; EU Risk Assessment Document – Draft 2001

[19] ATSDR: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry

Components Identified in Streams at Concentrations >5%	Acute Toxicity [only rat oral and inhalation data shown; data for other species and routes available for most components]	Genetic Point Mutation/Other Genetic Effects	Genetic Chromosome Aberration	Subchronic	Developmental	Reproduction	Other Panel Category or Other Program Addressing this Chemical	Toxicity Reviews/ References
Streams								
Pyrolysis Gasoline [C5-10 Fraction; Rerun Tower Overheads; approx. 40% benzene, 13% toluene, 26% C5, 20% other]	Rat oral LD50 > 2 g/kg;	Negative Ames Test, Drosophila; positive in mouse lymphoma , E.coli DNA repair , and transformation			No effects in rabbits in oral teratology study			Robust Summaries for acute oral, Ames, transformation, developmental; mouse lymphoma, DNA repair, Drosophila: Exxon Mobil, 1982
Pyrolysis Gasoline plus Rerun Tower Bottoms [Dripolene: C5+]	Rat oral LD50 > 2 g/kg							Robust Summary
Hydrogenated Pyrolysis Gasoline [Hydrotreated C6-8 Fraction] [55% benzene, 25% toluene, 10% xylene, 7% pentane, 7% ethylbenzene, 2% hexane, 3% cyclohexane]	Rat Oral LD50 = 5.17 g/kg; inhalation 4h LC50>12,408 ppm	Negative in Ames Test, in-vitro UDS; positive in transformation	Negative in micronucleus [mouse oral]	Rat 5 day inhalation: NOAEL 4869 ppm [deaths, bodyweight]				Robust Summaries

Table 4.
Read Across Data used to Characterize the Biodegradability of the High Benzene Naphtha Category from Chemicals Contained by Products in this Category and Chemically Complex Products not in this Category, but that Contain Like-Chemicals.

CHEMICAL / PRODUCT	CARBON NUMBER	PERCENT BIODEGRADATION(a) (28 days)	REFERENCE
n-Pentane	5	87	IHSC*
Isopentane	5	71	IHSC*
Cyclohexane	6	77	IHSC*
Alkenes, C6 Rich	6(b)	21	HOP**
1-Hexene (linear)	6	67-98(c)	****
Benzene	6	63	Robust Summary Provided with this test plan
Alkenes, C7-C9, C8 Rich	7-9	29	HOP**
p-Xylene	8	89	IHSC*
Styrene	8	100 (14 days)(c)	*****
Naphtha (Petroleum), light alkylate (gasoline stream)	5-8	42(d)	API***
Naphtha (Petroleum), Light Catalytically Cracked (gasoline stream)	5-8	74(d)	API***
Naphtha (Petroleum), Light Catalytically Reformed (gasoline stream)	5-9	96(d)	API***
C8-C10 Aromatics, Predominantly C9 Alkylbenzenes	9(b)	78	IHSC*
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	61	IHSC*

a OECD 301F, manometric respirometry test
b Predominant carbon number or range
c BOD test
d Test method for determining the inherent aerobic biodegradability of oil products and modification of ISO/DIS 14593
* Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)
** Robust summary from the Higher Olefins Panel HPV Test Plan (submitted)
*** Robust summary from the American Petroleum Institute: Gasoline Test Plan (to be submitted)
**** Chemicals Inspection and Testing Institute, Japan. 1992. These chemicals are in the OECD SIDS program.
**** Styrene is in the OECD SIDS program.

Table 5.
Composition (Weight Percent) of Three Gasoline Streams with Biodegradation Data Used to Read Across to Products in the High Benzene Naphthas Category.

Naphtha, (Pet.) Light Alkylate		**Naphtha, (Pet.) Light Catalytically Cracked**		**Naphtha, (Pet.) Light Catalytically Reformed**	
CAS# 64741-66-8	Weight %	CAS# 64741-55-5	Weight %	CAS# 64741-55-5	Weight %
Isopentane	12.61	n-hexane	1.69	n-heptane	3.59
2,3 dimethyl butane	4.74	n-pentane	1.71	n-hexane	4.69
2,4 dimethyl pentane	4.09	isopentane	4.7	n-pentane	8.05
2,3 dimethyl pentane	2.25	2,3 dimethyl pentane	1.12	Isopentane	11.39
2,2,4 trimethyl pentane	23.92	2 methyl hexane	1.58	2,2 dimethyl butane	1.26
2,2,3 trimethyl pentane	1.76	3 methyl hexane	1.45	2,3 dimethyl butane	1.11
2,3,3 trimethyl pentane	8.99	2 methyl pentane	3.64	2,3 dimethyl pentane	1.70
2,3,4 trimethyl pentane	11.56	3 methyl pentane	2.20	2 methyl hexane	4.30
2,3,5 trimethyl hexane	1.25	methyl cyclopentane	1.87	3 methyl hexane	5.18
2,5 dimethyl hexane	4.34	methyl cyclohexane	1.19	2 methyl pentane	5.17
2,4 dimethyl hexane	3.60	1-pentene	1.25	3 methyl pentane	4.00
2,3 dimethyl hexane	2.60	2-methyl-1-butene	2.31	benzene	8.37
1methyl-1ethyl cyclopentane	9.44	2-methyl-2-butene	5.35	toluene	29.77
		trans-2-pentene	3.33		
		cis-2-pentene	1.94		
		2-methyl-1-pentene	2.31		
		cis-3-hexene	1.67		
		trans-2-hexene	1.97		
		2-methyl-2-pentene	1.83		
		1-methyl cyclopentene	1.85		
		ethylbenzene	1.47		
		m-xylene	3.05		
		p-xylene	1.34		
		o-xylene	1.83		
		benzene	1.48		

	toluene	6.73	

Table 6.
Approximate Weight Percent and Carbon Number Comparison of Hydrocarbons in High Benzene Naphtha Category and Comparable Products (a).

Substance Name	Olefins		Aromatics		Paraffins	
	% (wt.)	C # (b)	% (wt.)	C # (b)	% (wt.)	C # (b)
Products in High Benzene Naphtha Category	**1-34**	**5-9**	**>40-100**	**6-11**	**>4-75**	**5-10**
Alkenes, C6 Rich	**100**	**5-7**	**0**	**-**	**0**	**-**
Alkenes, C7-9, C8 Rich	**100**	**7-9**	**0**	**-**	**0**	**-**
C8-C10 Aromatics, Predominantly C9 Aromatics	**0**	**-**	**>97**	**8-10**	**<3**	**-**
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	**0**	**-**	**>94**	**10-14**	**<6**	**-**
Naphtha (petroleum), Light Alkylate (gasoline stream)	**0**	**-**	**0**	**-**	**92**	**5-8**
Naphtha (petroleum), Light Catalytically Cracked (gasoline stream)	**24**	**5-6**	**16**	**6-8**	**21**	**5-7**
Naphtha (petroleum), Light Catalytically Reformed (gasoline stream)	**0**	**-**	**38**	**6-7**	**50**	**5-7**

a Approximate weight percent and carbon number ranges of the predominant chemical components by chemical class[olefins/aromatics/paraffins] for selected products contained by this category and for comparable products not in this category that have aquatic toxicity data that can be used as read across data for this category; % compositions may not total 100%.

b Predominant carbon number range

Table 7.
Acute Fish Toxicity Data for Selected Chemicals and Complex Products used to Characterize the Toxicity of Products in the High Benzene Naphtha Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (96-hr, mg/L)	REFERENCE
n-Pentane	5	*Oncorhynchus mykiss*	LC50 = 4.3	IHSC*
n-Hexane	6	*Pimephales promelas*	LC50 = 2.5	IHSC*
Benzene	6	*Oncorhynchus mykiss*	LC50 = 5.9	****
Alkenes, C6 Rich	5-7(b)	*Oncorhynchus mykiss*	LL50 = 12.8	HOP**
Mixed Cycloparaffins, C7-8, C7 Rich	7	*Oncorhynchus mykiss*	LC50 = 5.4(c)	IHSC*
Toluene	7	*Pimephales promelas*	LC50 = 14.6	IHSC*
Alkenes, C7-9, C8 Rich	7-9(b)	*Oncorhynchus mykiss*	LL50 = 8.9	HOP**
o-Xylene	8	*Pimephales promelas*	LC50 = 16.4	IHSC*
p-Xylene	8	*Oncorhynchus mykiss*	LC50 = 2.6	IHSC*
p-Xylene	8	*Pimephales promelas*	LC50 = 8.9	IHSC*
Ethylbenzene	8	*Pimephales promelas*	LC50 = 12.1	IHSC*
Naphtha (Petroleum), Light Alkylate (gasoline stream)	5-8(b)	*Pimephales promelas*	LL50 = 8.2	API***
Naphtha (petroleum), Light Catalytically Cracked (gasoline stream)	5-8(b)	*Pimephales promelas*	LL50 = 46	API***
Naphtha (petroleum), Light Catalytically Reformed (gasoline stream)	5-7(b)	*Pimephales promelas*	LL50 = 34	API***
1,2,4-Trimethyl-benzene	9	*Pimephales promelas*	LC50 = 7.7	IHSC*
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	*Oncorhynchus mykiss*	LL50 = 18.0	IHSC*
C8-C14 Aromatics, Predominantly alkyl Naphthalenes and Naphthalene	10-12(b)	*Oncorhynchus mykiss*	LL50 = 3.0	IHSC*

a Endpoint is mortality; LC = Lethal Concentration; LL = Lethal Loading; NOELR = No Observed Effect Loading Rate; values cited as "concentration" are based on measured values
b Predominant carbon number or range
c 93-hour value
* Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected

SIAR (to be submitted)

** Robust summary from the Higher Olefins Panel HPV Test Plan (submitted)

*** Robust summary from the American Petroleum Institute: Gasoline Test Plan (to be submitted)

**** Galassi, S., M. Mingazzini, L. Viagano, D. Cesareo, and M.L. Tosato, 1988. Benzene is in the OECD SIDS Program.

Table 8.
Acute Invertebrate Toxicity Data for Selected Chemicals and Complex Products used to Characterize the Toxicity of Products in the High Benzene Naphtha Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (48-hr, mg/L)	REFERENCE
n-Pentane	5	*Daphnia magna*	EC50 = 2.7	IHSC*
n-Hexane	6	*Daphnia magna*	EC50 = 2.1	IHSC*
Cyclohexane	6	*Daphnia magna*	EC50 = 0.9	IHSC*
Benzene	6	*Daphnia magna*	EC50 = 18(b)	***
o-Xylene	8	*Daphnia magna*	EC50 = 1.0	IHSC*
m-Xylene	8	*Daphnia magna*	EC50 = 4.7	IHSC*
Naphtha (Petroleum), Light Catalytically Reformed (gasoline stream)	5-7(c)	*Daphnia magna*	EL50 = 10	API**
Naphtha (Petroleum), Light Alkylate (gasoline stream)	5-8(c)	*Daphnia magna*	EL50 = 32	API**
Naphtha (Petroleum), Light Catalytically Cracked (gasoline stream)	5-8(c)	*Daphnia magna*	EL50 = 18	API**
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(c)	*Daphnia magna*	EL50 = 21.3	IHSC*
Naphthalene	10	*Daphnia magna*	EL50 = 16.7(d)	IHSC*
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(c)	*Daphnia magna*	EL50 = 3.0	IHSC*

a Endpoint is immobility; EC = Effect Concentration; EL = Effect Loading; NOELR = No Observed Effect Loading Rate; values cited as “concentration” are based on measured values

b 24-hour study

c Predominant carbon number or range

d Based on nominal values

* Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected

SIAR (to be submitted)

** Robust summary from the American Petroleum Institute: Gasoline Test Plan (to be submitted)

*** Galassi, S., M. Mingazzini, L. Viagano, D. Cesareo, and M.L. Tosato, 1988. Benzene is in the OECD SIDS program.

Table 9.
Alga Toxicity Data for Selected Chemicals and Complex Products Used to Characterize the Toxicity of Products in the High Benzene Naphtha Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (72-hr, mg/L)	REFERENCE
n-Pentane	5	*Pseudokirchneriella subcapitata(b)*	EbC50 = 10.7 ErC50 = 7.5 NOECb = 1.3 NOECr = 2.0	IHSC*
Benzene	6	*Pseudokirchneriella subcapitata*	EbL50 = 29	***
Naphtha (Petroleum), Light Catalytically reformed (gasoline stream)	5-7(c)	*Pseudokirchneriella subcapitata*	EbL50 = 8.5 NOELRb = 5.0	API**
Naphtha (Petroleum), Light alkylate (gasoline stream)	5-8(c)	*Pseudokirchneriella subcapitata*	EbL50 = 45 NOELRb = 18	API**
Naphtha (Petroleum), Light Catalytically Cracked (gasoline stream)	5-8(c)	*Pseudokirchneriella subcapitata*	EbL50 = 64 NOELRb = 51	API**
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(c)	*Pseudokirchneriella subcapitata*	EbL50 = 2.6 ErL50 = 2.9 NOELRb = 1.0 NOELRr = 1.0	IHSC*
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(c)	*Pseudokirchneriella subcapitata*	EbL50 = 1-3 ErL50 = 1-3 NOELRb = 1.0 NOELRr = 1.0	IHSC*

a Endpoint is growth inhibition; EbC = Effect Concentration for biomass); ErC = Effect Concentration for growth rate; EbL = Effect Loading for biomass; ErL = Effect Loading for growth rate; NOEC(b) = No Observed Effect Concentration for biomass; NOEC(r) = No Observed Effect Concentration for growth rate; NOELR(b) = No Observed Effect Loading Rate for biomass; NOELR(r) = No Observed Effect Loading Rate for growth rate; values cited as "concentration" are based on measured values

b Formerly known as *Selenastrum capricornutum*

c Predominant carbon number or range

* Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

** Robust summary from the American Petroleum Institute: Gasoline Test Plan (to be submitted)

*** Galassi, S., M. Mingazzini, L. Viagano, D. Cesareo, and M.L. Tosato, 1988. Benzene is in the OECD SIDS Program.

Table 10. Assessment Plan for High Benzene Naphthas Category Under the Program. (Robust summaries for existing studies are submitted separately.)

Stream Description	Human Health Effects						Ecotoxicity			Physical Chem.[1]	Environmental Fate			
	Acute Toxicity	Genetic Point Mut.	Genetic Chrom.	Sub-chronic	Develop-mental	Reproduc-tion	Acute Fish	Acute Invert.	Algal Toxicity		Photo-deg.	Hydro-lysis	Fugacity	Biodeg.
Pyrolysis Gasoline [15-67% benzene]	A	A	ACD	ACD	A	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Pyrolysis C6 Fraction [35-77% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Pyrolysis C6-C8 Fraction [30-80% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Pyrolysis C5-6 Fraction [70% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Hydrotreated C6 Fraction [75-76% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Hydrotreated C6-C7 Fraction [40-69% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Hydrotreated C6-C8 Fraction [40-60% benzene]	A	A	A	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Quench Loop Pyrolysis Oil [10-22% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Recovered Oil from Waste Water Treatment [NDA]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Extract from Benzene Extraction [60-75% benzene]	ACD	ACD	ACD	ACD	ACD	ACD	RA	RA	RA	CM	CM/TD	TD	CM	RA
Benzene [OECD SIDS; not member of category]	A	A	A	A	A	A	A	A	A	CM	CM/TD	TD	CM	A

1 Measured data for selected physicochemical endpoints will be identified in conjunction with calculated data to characterize this category.

A Adequate existing data available
ACD Adequate existing component data for read across (see Sec. III.A.)
TD Technical Discussion proposed
CM Computer Modeling proposed
RA Read Across (see Sec. III.C. and D.)

Table 11.
American Chemistry Council Olefins Panel Sponsored HPV Test Categories

Category Number	Category Description
1	Crude Butadiene C4
2	Low Butadiene C4
3	C5 Non-Cyclics
4	Propylene Streams (C3) - Propylene sponsored through ICCA
5	High Benzene Naphthas
6	Low Benzene Naphthas
7, 8, 9	Resin Oils and Cyclodiene Dimer Concentrates
10	Fuel Oils

Appendix I

ETHYLENE PROCESS DESCRIPTION

A. The Ethylene Process

1. Steam Cracking

Steam cracking is the predominant process used to produce ethylene. Various hydrocarbon feedstocks are used in the production of ethylene by steam cracking, including ethane, propane, butane, and liquid petroleum fractions such as condensate, naphtha, and gas oils. The feedstocks are normally saturated hydrocarbons but may contain minor amounts of unsaturates. These feedstocks are charged to the coils of a cracking furnace. Heat is transferred through the metal walls of the coils to the feedstock from hot flue gas, which is generated by combustion of fuels in the furnace firebox. The outlet of the cracking coil is usually maintained at relatively low pressure in order to obtain good yields to the desired products. Steam is also added to the coil and serves as a diluent to improve yields and to control coke formation. This step of the ethylene process is commonly referred to as "steam cracking" or simply "cracking" and the furnaces are frequently referred to as "crackers."

Subjecting the feedstocks to high temperatures results in the partial conversion of the feedstock to olefins. In the simplest example, feedstock ethane is partially converted to ethylene and hydrogen. Similarly, propane, butane, or the liquid feedstocks are also converted to ethylene. While the predominant products produced are ethylene and propylene, a wide range of additional products are also formed. These products range from methane (C1) through fuel oil (C12 and higher) and include other olefins, diolefins, aromatics and saturates (naphthenes and paraffins).

2. Refinery Gas Separation

Ethylene and propylene are also produced by separation of these olefins from refinery gas streams, such as from the light ends product of a catalytic cracking process or from coker offgas. This separation is similar to that used in steam crackers, and in some cases both refinery gas streams and steam cracking furnace effluents are combined and processed in a single finishing section. These refinery gas streams differ from cracked gas in that the refinery streams have a much narrower carbon number distribution, predominantly C2 and/or C3. Thus the finishing of these refinery gas streams yields primary ethylene and ethane, and/or propylene and propane.

B. Products of the Ethylene Process

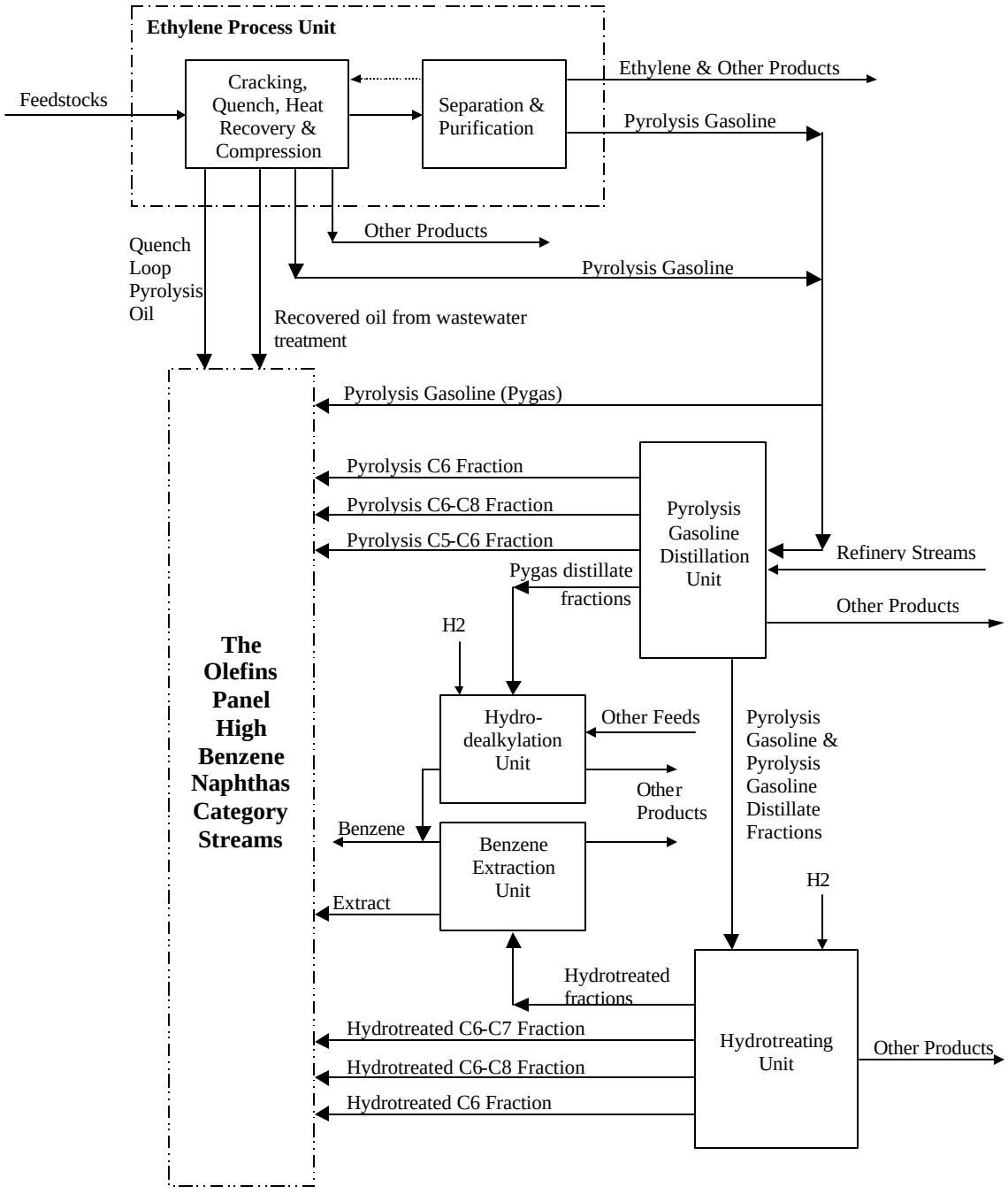
The intermediate stream that exits the cracking furnaces (i.e., the furnace effluent) is forwarded to the finishing section of the ethylene plant. The furnace effluent is commonly referred to as "cracked gas" and consists of a mixture of hydrogen, methane, and various hydrocarbon compounds with two

or more carbon atoms per molecule (C2+). The relative amount of each component in the cracked gas varies depending on what feedstocks are cracked and cracking process variables. Cracked gas may also contain relatively small concentrations of organic sulfur compounds that were present as impurities in the feedstock or were added to the feedstock to control coke formation. The cracked gas stream is cooled, compressed and then separated into the individual streams of the ethylene process. These streams can be sold commercially and/or put into further steps of the process to produce additional materials. In some ethylene processes, a liquid fuel oil product is produced when the cracked gas is initially cooled. The ethylene process is a closed process and the products are contained in pressure systems.

The final products of the ethylene process include hydrogen, methane (frequently used as fuel), and the high purity products ethylene and propylene. Other products of the ethylene process are typically mixed streams that are isolated by distillation according to boiling point ranges. It is a subset of these mixed streams that make up the constituents of the High Benzene Naphthas Category.

The chemical process operations that are associated with the process streams in the High Benzene Naphthas Category are shown in Figure 1.

Figure 1. Chemical Processing Operations Associated with Process Streams in the High Benzene Naphthas Category



AR201-13436B

CAS No.: 71-43-2
Robust Summary No.: OP E-002

Biodegradation

Test Substance:	CAS No. 71-43-2; Benzene
Method/Guideline:	OECD 301F
Year (guideline):	1993
Type (test type):	Ready Biodegradability, Manometric Respirometry Test
GLP:	Yes
Year (study performed):	2000
Inoculum:	Domestic activated sludge
Exposure Period:	28 days
Test Conditions: (FT - TC) • **Note: Concentration prep., vessel type, replication, test conditions.**	Activated sludge and test medium were combined prior to test material addition. Test medium consisted of glass distilled water and mineral salts (Phosphate buffer, Ferric chloride, Magnesium sulfate, Calcium chloride, EDTA). Test vessels were 500 mL dark glass bottles placed on a magnetic stirrer and electronically monitored for oxygen consumption. Test material and blanks were tested in triplicate, controls were tested in duplicate. Test material (benzene) concentration was 17mg/L. Sodium benzoate (positive control) concentration was 30mg/L. Toxicity control with benzene and Na Benzoate concentrations at 17 and 30 mg/L, respectively. Test temperature was 22 +/- 2 Deg C. All test vessels were stirred constantly for 28 days using magnetic stir bars and plates.
Results: (FT - RS) **Units/Value:** • **Note: Deviations from protocol or guideline, analytical method.**	Test material was readily biodegradable. Half-life was <2 weeks. By day 28, 63.0% degradation of the test material was observed. 10% biodegradation was achieved in less than 5 days, 50% biodegradation on approximately day 5. By day 5, >60% biodegradation of positive control was observed, which meets the guideline requirement. No excursions from the protocol were noted. Biodegradation was based on oxygen consumption and the theoretical oxygen demand of the test material as calculated using results of an elemental analysis of the test material.

Sample	% Degradation* (day 28)	Mean % Degradation (day 28)
Benzene	54, 72, 63	63
Na Benzoate	65, 75	70
Toxicity Control	59, 65	62

* replicate data

Conclusion: (FT - CL)

Biodegradation

Reliability: (FT - RL)	(1) Reliable without restriction
Reference: (FT - RE)	Brixham Environmental Laboratory. 2001. OECD 301F, Ready biodegradability: Manometric respirometry. Study # AH0378/A.
Other (source): (FT - SO)	Olefins Panel, American Chemistry Council

* IUCLID field abbreviations include:
FT - Freetext
TC - Test Conditions
RS - Results
CL - Conclusion
RL - Reliability
RE - Reference
SO - Source

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Dripolene. Yellow, homogeneous liquid, stable for 5 years at ambient temperature. (CRU #93329)
Method	
Method/guideline followed	Not specified
Type (test type)	Acute, limit test
GLP	Yes
Year	1994
Species/Strain	Rat, Sprague-Dawley
Sex	Males and females
No. of animals per sex per dose	5
Vehicle	None
Route of administration	Oral gavage
Test Conditions	Sprague Dawley rats (180-350g) were individually housed in stainless steel suspended cages and fasted overnight prior to administration of 2g/kg neat dripolene. The study room was maintained at 68-72^{0}F with a relative humidity of 35-63% and a 12 hr light-dark cycle. Water and chow diet were available ad lib after dosing. Test article was administered once on day 1 by oral gavage through a blunted needle. Rats were observed for clinical signs approx. 30 min, 1hr, and 4hr, after dosing, and daily thereafter until sacrifice on day 15. Rats were checked once a day for mortality and moribundity. Observations were not made on weekends. Body wts were recorded prior to fasting and on days 1, 8 and 15.
Results	
LD_{50} with confidence limits.	The LD_{50} was not reached at 2g/kg. There were no deaths and all rats gained some weight during the study. Clinical signs noted in one or more rats were salivation, decreased activity, rales, lacrimation, chromodacryorrhea, ataxia, head shaking, chromorhinorrhea, miosis, slight tremors, mydriasis, hyperactivity, hypothermia, urogenital discharge, nasal discharge, decreased food consumption, decreased fecal output, vocalization, and decreased stool size. No gross pathological findings were noted at necropsy.
Remarks	
Conclusions (study author)	The LD_{50} was not reached at 2g/kg.
Data Quality Reliability	**1.** Reliable without restriction.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Acute oral toxicity of dripolene in Sprague Dawley Rats. Study #65642. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ.
Other *Last changed*	10/23/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Dripolene. Yellow, homogeneous liquid, stable for 5 years at ambient temperature. (CRU #93329)
Method	
Method/guideline followed	Not specified
Type (test type)	Acute, limit test
GLP	Yes
Year	1994
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	3
Vehicle	None
Route of administration	dermal
Test Conditions	Rabbits, weighing at least 2kg, were individually housed in stainless steel suspended cages in a study room maintained at 69-72^{0}F with a relative humidity of 40-85% and a 12 hr light-dark cycle. Water and chow diet were available ad lib. The dorsal skin surface extending down from the front to rear legs and from left to right lower flanks was clipped free of hair the day prior to test article administration. Test article was spread evenly over the clipped area (approx. 10% of body surface area) at a dose of 2g/kg. A layer of 8-ply gauze was placed on the dorsal site, and a rubber dam sleeve was fitted snugly over the gauze pad and around the trunk. Edges of the dam were taped in place. An Elizabethan collar was affixed to the neck to prevent oral ingestion of test article and mechanical irritation of the test site. After 24 hrs, the collar and wrappings were removed and residual test article was wiped off. Body wts were recorded on days 1, 8 and 15. Rabbits were observed for toxicity at about 1 and 2 hr post-dose and daily thereafter on weekdays, through day 14. Observations for mortality/moribundity were made daily. Rabbits were sacrificed on day 15 and necropsies were performed.
Results	
LD_{50} with confidence limits.	The LD_{50} was not reached at 2g/kg. There were no deaths during the study and rabbits either gained some weight or remained at day 1 body wt. Signs that might have resulted from treatment in one or more rabbits were: decreased fecal output, decreased fecal pellet size, soft stool, and decreased food consumption. No gross pathological findings were noted at necropsy.
Remarks	
Conclusions	
(study author)	The LD_{50} was not reached at 2g/kg.
Data Quality	
Reliability	**1.** Reliable without restriction.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Dermal toxicity of dripolene in the New Zealand White rabbit. Study #65643. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ.
Other	
Last changed	10/23/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Dripolene. Yellow, homogeneous liquid. Stable for 5 years at ambient temperature (CRU #93329)
Method	
Method/guideline followed	Not specified.
Type (test type)	Acute irritation
GLP	Yes
Year	1994
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	3
Vehicle	None
Route of administration	Dermal
Test Conditions	Three males and 3 female rabbits, weighing at least 2kg, were individually housed in stainless steel suspended cages in a room maintained at 69-72^{0}F with relative humidity of 38-85% and 12hr light-dark cycle. Water and chow diet were available ad lib. One 1sq. inch test site was selected on the right anterior flank of 4 animals and the left anterior flank of 2 animals. The sites were designated as anterior flank (1-hr occlusion) test sites. A second 1 sq. inch test site was selected on the right posterior flank of 4 animals and the left posterior flank of 2 animals. The sites were designated as posterior flank (4-hr occlusion) test sites. The test sites were not abraded. 0.5ml of test substance was applied to the posterior test site under 1 sq. inch Webril patch. The patch was secured to the skin with an occlusive rubber dam followed by surgical tape. 0.5ml of test substance was applied to the anterior test site under a 1 sq. inch patch and similarly secured. Following 1hr exposure, the anterior patch was removed and the site evaluated for DOT corrosion. This site was reevaluated at 48hrs post-dosing. After the initial evaluation, residual test substance was removed by gently wiping the site with saline dampened cotton. Following a 4hr exposure, the posterior patch was removed and the site evaluated for DOT corrosion and OSHA Primary Irritation Index (PII). This site was reevaluated at 48hrs post-dosing. After the initial evaluation, the residual test substance was removed by gently wiping the site with saline dampened cotton. The posterior test site was also evaluated for dermal irritation according to the Draize method at 4.5, 28, 52, and 76hrs and at 7, 10 and 14 days post-dosing. Clinical observations were recorded at approx. 1hr and 4hr post-dosing and daily thereafter. The condition of each animal was checked once daily in the morning. The rabbits in this study were concurrently evaluated for ocular irritation to reduce the number of animals used. (Study 65644, see separate summary)
Results	The test material was negative for DOT corrosion after 1hr and 4hr occlusions and 48hr post-dose. After the 4hr occlusion, rabbits showed well-defined erythema (Draize score 2.2) and slight edema (Draize score 2.2) that cleared almost completely after 14 days (Draize scores<1.0). The OSHA PII score was 3.9, corresponding to a rating of "non-irritant". Skin flaking in 4 rabbits and skin cracking in 2 rabbits were observed on day 7.
Remarks	
Conclusions (study author)	The test article was rated non-corrosive by DOT criteria after 1hr and 4hr occlusions, and non-irritating by OSHA PII criteria.
Data Quality	
Reliability	**1.** Reliable without restrictions.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Acute dermal irritation/corrosion of dripolene in the New Zeakand White rabbit. Study #65644. Stonybrook Laboratories, Inc., Princeton, NJ. for Mobil Chemical Co., Edison, NJ
Other	
Last changed	10/23/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Dripolene. Yellow, homogeneous liquid, stable for 5 years at ambient temperature. (CRU #93329)
Method	
Method/guideline followed	Not specified
Type (test type)	Acute irritation
GLP	Yes
Year	1994
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	3
Vehicle	None
Route of administration	Instillation into conjunctival sac
Test Conditions	Rabbits, weighing at least 2kg, were individually housed in stainless steel suspended cages in a study room maintained at 69-72^{0}F with relative humidity of 40-85% and a 12 hr light-dark cycle. Water and chow diet were available ad lib. The left eye was designated as the test eye and the right eye served as untreated control; 0.1ml of test article was instilled into the left conjunctival sac of 3 males and 3 females. Both eyes were grossly examined and the test eye was scored according to the Draize method at 1, 24, 48 and 72 hrs post-dose. The rabbits tested in this study were also concurrently evaluated for dermal irritation/corrosion to reduce the number of animals used (Study #65645 - see separate summary).
Results	
Remarks	Slight irritation of the iris was seen at 1 hr., which gradually resolved over 10 days; conjunctivae and cornea were irritated to a much greater extent but the effect also resolved over the 10-day post-dose period. One hour Draize scores were cornea, 16.7; iris, 2.5 and conjunctivae, 15.3. Total scores were: 1 hr. 34.5; 24 hr. 15.3; 48 hr, 10.7; 72 hr 9.9; 7 days, 4.5; 10 days, 1.7. Four rabbits had corneal ulceration; conjunctival redness and swelling; two of these rabbits had corneal opacity and iritis.
Conclusions	
(study author)	Total Draize scores were: 1 hr. 34.5; 24 hr. 15.3; 48 hr, 10.7; 72 hr 9.9; 7 days, 4.5; 10 days, 1.7. Four rabbits had corneal ulceration; conjunctival redness and swelling; two of these rabbits had corneal opacity and iritis.
Data Quality	
Reliability	**1.** Reliable without restriction.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Ocular irritation of dripolene in the New Zealand White rabbit. Study #65644. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ. Rodriguez, S.C. and Dalbey, W.E. 1994. Acute dermal irritation/corrosion of dripolene in the New Zealand White rabbit. Study #65645. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ.
Other	
Last changed	10/23/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Hydrogenated Pyrolysis Gasoline CAS# 68410-97-9. Clear liquid, aromatic odor
Method	
Method/guideline followed	Standard method (not referenced) with doses based on a limit test and range-finding study
Type (test type)	Acute LD50
GLP	Yes
Year	1984
Species/Strain	Rat, Fischer 344
Sex	Males and females
No. of animals per sex per dose	5
Vehicle	None
Route of administration	Oral
Test Conditions	Rats (99.9-134.0 g; 57 days old) were individually housed in screen-bottomed cages in a room with 70.6^{0}F temperature, relative humidity of 59% and a 12 hr light/dark cycle. Chow diet and tap water from an automatic watering system were available ad lib. Rats were fasted for 24 hours prior to dosing at 4.2, 4.6, 5.0, and 5.4g/kg and observed at 1 and 4 hrs after dosing on day 1, and daily thereafter, over 14 days for clinical signs, morbidity and mortality. Gross necropsies were performed on all rats. LD50 was calculated by Probit analysis.
Results	
LD_{50} with confidence limits.	LD50 = 5.17g/kg (95% confidence limits: 5.02-5.45g/kg)
Remarks	On day 1, males and females showed dose responsive increases in ataxia, harsh respiratory sounds, and a non-dose responsive increase in red ocular discharge. Soft feces were observed in treated males and females on day 2. Frequency of clinical signs decreased by day 3 and signs were absent by day 5. There were no changes in body weight gain among the groups. Male and female mortalities were combined to calculate an LD50. Mortality from a previously performed limit test, conducted at 5.0g/kg was combined with results from the 5.0g/kg dose in this definitive study, raising that group number to 20. Mortalities were: 0/10 at 4.2, and 4.6g/kg, 7/20 at 5.0g/kg, 7/10 at 5.4g/kg. Gross necropsies revealed red lungs, gas-filled stomach and intestine, mottled liver, discoloration of kidney, and opaque eyes in rats that died during the study. These observations, with the exception of opacity in the left eye of one 5.4g/kg female, were absent in rats sacrificed at study termination (day 15).
Conclusions (study author)	The acute median lethal dose (LD50) for Hydrogenated Pyrolysis Gasoline in male and female rats was 5.17g/kg. A descriptive classification of Practically Non-toxic for acute oral exposure was assigned.
Data Quality	
Reliability	**1.** Reliable without restrictions.
References	Rausina, G.A. 1984. Acute oral toxicity study in rats of hydrogenated pyrolysis gasoline. Proj. #2091. Gulf Life Sciences Center, Pittsburgh, PA
Other	
Last change	5/7/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Hydrogenated Pyrolysis Gasoline CAS# 68410-97-9. Clear liquid, aromatic odor
Method	
Method/guideline followed	Standard method (not referenced)
Type (test type)	Acute LC50
GLP	Yes
Year	1984
Species/Strain	Rat, Fischer 344
Sex	Males and females
No. of animals per sex /dose	5
Vehicle	Filtered air
Route of administration	Inhalation
Test Conditions	Rats (8 wks. old, 100-172g at initiation) were individually housed in stainless steel, screen-bottomed cages in a room maintained at 73.0^0F (75.5^0F during exposure) temperature, relative humidity of 51% (40% during exposure) and a 12 hr light/dark cycle. Rats received chow diet and tap water ad lib, except during exposure. One group of 10 rats was exposed to aerosolized test article generated by a ball jet nebulizer for 4 hrs. A condensing flask was used to prevent large particles from entering the chamber. Actual average chamber concentration was 12,408ppm (range 8,642-17,371ppm) determined by gas chromatography. Particulate phase was negligible. Rats were observed for clinical signs at 1 and 4 hrs after dosing on day 1 and daily thereafter over 14 days, and for morbidity and mortality twice daily on weekdays, once daily on weekends. Body wt. was determined at initiation and on days 8 and 15. Gross necropsies were performed on all rats at termination on day 15.
Results	
LC_{50} with confidence limits.	LC50>12,408ppm
Remarks	There were no deaths during the study, no effects on body wt gain, and no gross alterations were seen at necropsy. Immediately after exposure, all rats exhibited lethargy, increased and labored respiration, and ocular discharge; most animals showed twitching and dry red material around nose/mouth. There were a few instances of harsh respiratory sounds, trembling, and perianal soiling. These clinical signs decreased in frequency by 4 hr post-exposure and disappeared by day 2.
Conclusions (study author)	No deaths occurred at the dose of 12,408ppm of test article, indicating a descriptive classification of Practically Non-toxic for acute inhalation exposure. Clinical signs noted immediately after exposure (increased/labored respiration, twitching, trembling, lethargy, ocular discharge) were not observed by day 2 and thereafter.
Data Quality Reliability	**1.** Reliable without restrictions.
References	Rausina, G.A. 1984. Acute inhalation toxicity study in rats of hydrogenated pyrolysis gasoline. Proj. #2092. Gulf Life Sciences Center, Pittsburgh, PA
Other	
Last change	Revised 7/27/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Genetic Toxicity - in Vitro

Test Substance	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9. clear liquid with aromatic odor, negligible solubility in water, contains <55.0% benzene, <25% toluene, <10% dimethyl benzene/xylene, <7% pentane, <7% ethylbenzene, <3% cyclohexane, <2% hexane
Test substance	
Method	
Method/guideline followed	Standard method per Ames et al
Type	Reverse mutation bacterial assay
System of testing	Salmonella typhimurium, Escherichia coli with and without metabolic activation
GLP	Yes
Year	1991
Species/Strain	S. typh. TA1535, TA1537, TA98, TA100; E. coli WP2(uvrA)
Metabolic activation	Yes
Species and cell type	Male Sprague Dawley rat liver (S9 fraction), Molecular Toxicology, Inc., Annapolis, MD
Quantity	20% S9 fraction in 0.5ml S9 mix/plate
Induced or not induced	Aroclor 1254induced, rats given a single 500mg/kg ip dose
Concentrations tested	0, 33, 100, 333, 1000, 3333, 10,000µg/plate ± S9. All diluted in acetone (200mg/ml)
Statistical Methods	None specified. Test article considered mutagenic when it induces a reproductive, dose-related increase in number of revertants in one or more strains at 3 consecutive dose levels. A non-mutagen does not induce a dose-related increase in at least 2 independent tests.
Remarks for Test Conditions	Hydrogenated pyrolysis gasoline (HPG) was prepared in acetone immediately prior to use. At end of the study, an aliquot of the stock dilution was sent to PTRL West, Richmond, CA to confirm concentration. Salmonella (approx. 10^8cells/ml) were exposed to either test material or acetone in 3 plates/dose ± S9 by the plate incorporation method. Six dose levels from 33-10,000µg/plate were employed in both the range-finding trial using TA100 and the mutagenicity test with all strains of Salmonella and E. coli. Optimum level of S9 for the mutagenicity assay was determined by testing the highest non-toxic dose, 10,000µg per plate with metabolic activation systems containing 4, 20 or 80% S9 fraction. No noteworthy increases in revertants or cytotoxicity was observed at any S9 concentration; 20% S9 was used in the mutagenicity test. All plates were incubated at 37^0C for 48 hrs then revertant colonies were counted. Positive control compounds were: cultures-S9, sodium azide (5µg/plate) for TA1535, TA100; 9-aminoacridine (50µg/plate) for TA1537; 2-nitrofluorene (5µg/plate) for TA98; N-ethyl-N'-Nitro-N-Nitrosoguanidene (5ug/plate) for E. coli WP2, and cultures+S9, 2-anthramine (4µg/plate) for TA1535, TA1537, (2µg/plate) for TA98, TA100, and (20µg/plate) for E. coli WP2. Two independent assays were performed.
Results	HPG did not induce increases in number of revertant colonies and no toxicity was observed in any Salmonella strain or E. coli WP2 with or without 20% S9 metabolic activation in both studies. Positive control compounds performed appropriately.
Genotoxic effects	
Conclusions	Hydrogenated pyrolysis gasoline is not mutagenic to bacteria under conditions of this assay.
(contractor)	
Data Quality	
Reliabilities	**1**. Reliable without restriction
Reference	Riccio, E.S. and Stewart, K.R. 1991. Salmonella-Escherichia coli/microsome plate incorporation assay of Hydrogenated Pyrolysis Gasoline. SRI Study #2545-A03-91, Sponsor study #91-66. SRI International, Menlo Park, CA for Chevron Environmental Health Center, Richmond, CA
Other	
Last changed	5/7/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Genetic Toxicity - in Vitro

Test Substance	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9. clear liquid with aromatic odor.
Test substance	Composition, purity and stability referred to sponsor.
Method	
Method/guideline followed	Standard method based on Cortesi et al (1983), Dunkel et al (1981), Reznikoff et al (1973)
Type	In vitro cell transformation
System of testing	Mouse embryo cells
GLP	Yes
Year	1984
Species/Strain	BALB/3T3-A31-1-1 from T. Kakunaga, National Cancer Inst., 1983
Metabolic activation	No
Species and cell type	NA
Quantity	NA
Induced or not induced	NA
Concentrations tested	Cytotoxicity: 8, 16, 32, 64, 128, 256, 512, 1024, 2048, and 5000µg/ml; Transformation: 100, 250, 500, 1500µg/ml, all diluted in 10% Pluronic® polyol F68 (prepared in deionized water, mol. wt. 8350, 80% hydrophilic).
Exposure period	2 days
Statistical Methods	None employed. Criteria for positive response were a two-fold increase in type III foci at the highest dose over vehicle control (at least 2 type III foci if vehicle control had none) with or without a dose related response, or a two-fold increase at two or more consecutive doses. Test is equivocal if two-fold increase occurred at any one level other than the highest acceptable dose.
Remarks for Test Conditions	Sufficient Hydrogenated Pyrolysis Gasoline (HPG) was weighed separately for each dose level, 0.40ml of 10% F68 added per ml of final volume and medium (Eagles MEM with 10% heat-inactivated fetal calf serum) added as required to achieve final volume for testing. Test preparations were mixed just prior to addition to cultures at 50µl to each 5 ml culture. All cultures were incubated at 37^0C in 5% CO_2 enriched humidified atmosphere. For cytotoxicity, 2 cultures/dose group, 2 cultures for vehicle F68 or medium negative control were seeded with $1x10^4$ cells/plate in day 1, exposed on days 2-3, trypsinized and counted with a Coulter Model ZB on day 4 for at least 20% survival. For transformation, 15 cultures ($1x10^4$ cells/flask/dose group)) and two colony-forming cultures (100 cells/plate/dose group) were seeded on day 1, exposed on days 2-3 and culture medium changed on day 4. For transformation cultures, medium continued to be changed weekly to day 29. Positive control was 3-methylcholanthrene (1µg/ml). Colony forming cultures were fixed, stained, and counted visually on day 10 to determine cloning efficiency (avg. number colonies/plate ÷ 100 cells seeded). Transformation cultures were fixed and stained on day 29 for focus counting and evaluation. Transformation frequency = total type III foci ÷ total flasks/dose group.
Results	
Genotoxic effects	HPG induced toxicity in BALB/3T3 cells after two days exposure beginning at 128 µg/ml (45.4% relative survival) with relative survivals of 26.7, 25.6, 3.2 and 0% at 512, 1024, 2048 and 5000µg/ml, respectively. In the transformation assay, toxicity was seen at all dose levels (relative cloning efficiencies of 53.7, 67.8, 78.5 and 0% at 100, 250, 500 and 1500µg/ml). At 1500µg/ml, the highest dose level, HPG induced 5 Type III foci; no other dose levels produced a positive response. Transformation frequencies were 0.13, 0, 0, 0.07 and 0.36 for medium control, vehicle control, 100, 250, 500 and 1500µg/ml, respectively. Positive and negative controls gave appropriate responses.
Conclusions	
(contractor)	Hydrogenated Pyrolysis Gasoline induced transformation in BALB/3T3 cells under conditions of this assay. Cytotoxicity and impairment of cloning efficiency were also observed. The positive response was observed only at the highest dose level, a level that appeared to be too toxic for cells to recover and form colonies (0% relative colony forming efficiency)

Data Quality *Reliabilities*	**1.** Reliable without restriction
Reference	Brecher, S. 1984. Transformation test of Hydrogenated Pyrolysis Gasoline. Proj. #2098. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co, Houston, TX Cortesi, E. et al. 1983. Teratogenesis, Carcinogenesis, Mutagenesis 3: 101-110. Dunkel, V.A. et al. 1981. J. Nat'l Cancer Inst. 67: 1303-1315. Reznikoff, C.A. et al. 1973. Cancer Res. 3239-3249.
Other *Last changed*	Revised 8/27/2001 (Prepared by a contractor to the Olefins Panel).

Robust Summary - Group 5: High Benzene Naphthas

Genetic Toxicity - in Vitro

Test Substance	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9. clear liquid with aromatic odor.
Test substance	Composition, purity and stability referred to sponsor.
Method	
Method/guideline followed	Standard method based on Williams et al (1977, 1982)
Type	In vitro mammalian DNA repair assay
System of testing	Unscheduled DNA synthesis (UDS) in primary hepatocyte cultures
GLP	Yes
Year	1984
Species/Strain	Fischer 344 male rat (10 wks old)
Metabolic activation	No
Species and cell type	NA
Quantity	NA
Induced or not induced	NA
Concentrations tested	8, 16, 32, 64, 128, 256, 512, 1024µg/ml diluted in 10% Pluronic F68 (prepared in deionized water, mol. wt 8350, 80% hydrophilic)
Exposure period	18 hrs.
Statistical Methods	None specified. Criteria for positive response are incorporation of radioactive precursor (^{3}H-thymidine) in cells that are not normally synthesizing DNA, indicating repair of damage. A positive response is defined as a mean net nuclear grain count at any treatment level that exceeds concurrent negative control by at least 6 grains/nucleus; negative control value must not exceed 5 grains. If this criterion is not met, a positive response can be identified if there is a significant difference ($p<0.01$) in % cells in repair at any dose level and negative control value. This indicator defines whether a small fraction of cells is undergoing repair (Casciano & Gaylor, 1983). A positive response need not be dose related.
Remarks for Test Conditions	Sufficient Hydrogenated Pyrolysis Gasoline (HPG) was weighed separately for each dose level, 0.40ml of 10% F68 added per ml of final volume and sufficient medium (Williams Medium E with 10% fetal bovine serum and insulin) added to achieve final volume. Test preparations were mixed just prior to addition at 20µl to each 2ml culture. The conc. of ^{3}H-thymidine (½ life 12.4 yrs.) used in these assays was 1mCi/ml. All cultures were incubated at 37^0C in 5% CO_2 enriched humidified atmosphere. No range finding assay was performed. In the UDS assay, $2x10^5$ cells/ml were seeded into coverslip cultures, exposed to ^{3}H-thymidine and test substance for 18 hours (3 cultures/dose level, 8 dose levels), untreated controls, vehicle F68 control and positive control, 2-acetyl aminofluorene (0.01µg/ml). Cells growing on coverslips were rinsed, fixed and glued to microscope slides on day 2. On day 3, slides were dipped in autoradiographic emulsion and stored in the dark at 2-8^0C. Autoradiographs were developed, stained and coverslipped on day 10. Numbers of grains overlying 50 randomly selected nuclei/slide were counted. The highest of 3 cytoplasmic grain counts/cell were subtracted and this number was divided by a conversion factor (unspecified) to obtain net nuclear grain count. Avg. net nuclear grain count/slide (sum of net nuclear grain count ÷ 50) and mean net nuclear grain count (avg. net nuclear grain count/slide ÷3) were calculated. In addition, % cells in repair were determined for each dose level.
Results	
Genotoxic effects	HPG induced toxicity in primary hepatocytes following 18 hr exposure that left too few cells for UDS analysis at doses of 512 and 1024µg/ml. HPG did not induce unscheduled DNA synthesis at any dose level with sufficient cells to be analyzed. Positive and negative controls gave appropriate responses.
Conclusions	
(contractor)	Hydrogenated Pyrolysis Gasoline did not induce unscheduled DNA synthesis in primary cultures of rat hepatocytes under conditions of this assay.

Data Quality *Reliabilities*	**2.** Reliable with restrictions. No table of cell counts/viability. No individual data to verify calculations and identify conversion factor. Statistical criteria are mentioned but method is not cited.
Reference	Brecher, S. 1984. Hepatocyte primary culture/DNA repair test of Hydrogenated Pyrolysis Gasoline. Proj. # 2097. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX Williams, G.M. 1977. Cancer Res. 37: 1845-1851 Williams et al. 1977. In Vitro 13: 809-817 Williams et al. 1982. Mut. Res. 97:359-370 Casciano, D.A. and Gaylor, D.W. 1983. Mut. Res. 122:81-86
Other *Last changed*	5/7/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Genetic Toxicity - in Vivo

Test Substance	
Remarks	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9. Clear liquid with aromatic odor. Compositional analysis, purity and stability referred to sponsor.
Method	
Method/guideline followed	None specified. Comparable to standard assay.
Type	Mammalian bone marrow erythrocyte micronucleus assay
GLP	Yes
Year	1984
Species	Mice
Strain	Crl:CD-1(ICR)BR Swiss
Sex	Male and female. Range-finding 2M, 2F (10 wks old)/group; 3 groups; Micronucleus test 10M, 10F (11 wks old)/group in 4 groups, 15M, 15F in one group.
Route of administration	Oral gavage
Doses/concentration levels	0, 0.5, 1.0, 2.0g/kg (2doses), 2.0g/kg (1 dose) undiluted
Exposure period	1 dose/day for 2 days: one group- 1 dose, 1 day only
Statistical methods	Values from treated groups for daily mean body weights, group means and std. dev. for polychromatic erythrocytes (PCEs) with micronuclei (MN) , and group mean ratios of PCE to normochromatic erythrocytes (NORMs) were calculated and compared with vehicle control values by Student's t-test. Positive response was indicated by statistically significant ($p<0.05$) increases in micronucleated PCE at any dose level with a dose related response evident. Results were considered equivocal if only one of these criteria was met.
Remarks for Test Conditions.	Animals in the range-finding study (2M, 2F/group), 3 treated groups (no control group) were given 1.25, 2.5, and 5.0g/kg neat hydrogenated pyrolysis gasoline (HPG) by gavage once each day for two days. Eighty percent of the dose level that produced =50% mortality was selected for the maximum dose in the micronucleus study. In the micronucleus study, three groups of mice were given undiluted HPG by oral gavage daily for two days at doses of 0.5, 1.0, 2.0g/kg, negative control mice were given corn oil (5g/kg). One-half of each treated group and negative control (5M, 5F) was killed on day 3 and the remainder on day 4. One group (15M, 15F), given 2.0 g/kg by gavage in a single dose for 1 day only, was killed on days 2, 3, 4 (5/sex/day). Positive control mice (4M, 4F) given cyclophosphamide (75 mg/kg) ip daily for 2 days were killed on day 3. Survival, body wt, and clinical signs were observed and recorded daily. Slides of femoral bone marrow smears were prepared, stained with May-Grunewald/Giemsa stain and examined microscopically. For each mouse, 1000 PCE and all associated mature erythrocytes (NORMs) were counted. Data collected included group mean body weights for each day, total PCEs, total NORMs, PCEs with MN, and NORMs with MN.
Results	
Genotoxic effects	NOAELmortality = 1.0g/kg; NOELgenetics > 2.0g/kg (Assigned by reviewer)
NOAEL (NOEL)	In the range-finding study, half of the animals given HPG at conc of 5.0g/kg died on or before day 2. Gross necropsy of dead mice was unremarkable. In the micronucleus test, 1/10 males given 2.0g/kg (2 doses) died on day 2. No other mortality or significant wt changes were observed. Lethargy was observed among high dose mice. Surviving mice treated with HPG did not show any significant increase in micronucleus formation in PCE and no significant changes in ratio of PCE/NORM compared to negative controls. Negative and positive controls gave appropriate results.
LOAEL (LOEL)	
Conclusions	
(study authors)	Oral treatment of mice with Hydrogenated Pyrolysis Gasoline for 1-2 days at doses up to 2.0g/kg/day had no effect on frequency of micronucleated polychromatic erythrocytes in bone marrow under these test conditions. HPG did not induce cytogenetic damage.

Data Quality	
Reliabilities	**1.** Reliable without restriction
References	Khan, S.H. 1984. Micronucleus test of Hydrogenated Pyrolysis Gasoline. Proj. #2096. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX
Other	
Last changed	5/7/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Repeated Dose Toxicity

Test Substance	Hydrogenated Pyrolysis Gasoline CAS #68410-97-9, Clear liquid with aromatic odor.
Remarks	
Method	
Method/guideline followed	Standard method, method not referenced
Test type	Subacute
GLP	Yes
Year	1984
Species	Rat
Strain	Fischer 344
Route of administration	Inhalation
Duration of test	8 days
Doses/concentration levels	0, 4869±470, 9137±917ppm±SD, actual exposure conc.
Sex	Males and females (5/sex/group)
Exposure period	6 hrs.
Frequency of treatment	once daily for 5 days (d1-5)
Control group and treatment	5M, 5F; filtered air
Post exposure observation period	2 days
Statistical methods	Body wt variance compared by Bartlett's test and one way analysis of variance. Group mean body wt compared either with Dunnett's test or a modified t-test to assess significance.
Test Conditions	Rats (9 wks old, 113-195g at initiation) were housed individually in stainless steel, screen-bottomed cages. Rooms were maintained at 72.2^0F (exposure chamber 75^0F) with relative humidity of 54% (exposure chamber 50%), and 12 hr light/dark cycle. Rats received chow diet and tap water ad lib throughout the study, except during exposure. Three groups of 10 rats (5M, 5F/group) each, were exposed to test article or air. Test article was aerosolized with a ball jet nebulizer; an in-line condensing flask was used to prevent large particles from entering the exposure chamber. Chamber concentration of test article was measured by gas chromatography. Rats were observed twice daily on weekdays and once daily on weekends for morbidity/mortality, and once daily for clinical signs immediately after exposure on days 1-5. Surviving rats were sacrificed on day 8. Gross necropsies were performed on all rats.
Results	
NOAEL (NOEL)	NOAEL< 4869ppm (estimated by reviewer)
LOAEL (LOEL)	LOAEL= 4869ppm (estimated by reviewer) based on clinical observations, reduced wt gain.
Remarks	Two rats (1M, 1F) from group 3 (9137ppm) died on day 2; one female from group 3 died during exposure on day 1. Rats in groups 2 and 3 showed ocular discharge throughout d1-5. Rats in group 2 showed increased respiratory rate and dry red material around nose and mouth. All rats in group 2 were lethargic and showed labored respiration. Many rats in group 3 were lethargic and exhibited twitching and harsh respiratory sounds during days 1-5. All rats in group 2 and all but one survivor in group 3 appeared normal on day 8. Group mean body wt was significantly decreased in a dose related manner. No test article related effects were seen at gross necropsy on day 8; the male rat that died during the study showed gas in the G.I. tract and red-tinged fluid in the stomach.
Conclusions (study authors)	Exposure to test article caused a significant decrease in group mean body wt of male and female rats of low and high dose groups that was correlated with exposure level. Three deaths occurred in the high dose group during exposure. Major clinical signs were lethargy, twitching, harsh respiratory sounds and ocular discharge. No gross alterations were found in rats surviving to sacrifice.
Quality Reliabilities	**1.** Reliable without restrictions
References	Rausina, G.A. 1984. Five-day repeated dose inhalation toxicity study in rats of Hydrogenated Pyrolysis Gasoline. Proj. #2099. Gulf Life Sciences Center, Pittsburgh, PA
Other	
Last changed	Revised 7/27/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary – Group 5: High Benzene Naphthas

Fish Acute Toxicity

Test Substance	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9. 100% pure, colorless liquid.. Composition and stability referred to sponsor.
Method	
Method/guideline followed	OECD Guideline #203, US EPA 40CFR, Part 797.1400
Year (guideline)	1992
Type (test type)	Static Fish Acute Toxicity- Water Accommodated Fraction (WAF)
GLP	Yes
Year (study performed)	1993
Species	Rainbow trout (Oncorhynchus mykiss) from Westacre Trout Farm, Norfolk, UK
Analytical Monitoring	Total carbon analysis using Ionics TC/TOC Model 555 with infra-red gas analyzer to verify concentrations of 0,32, and 320mg/L(WAF)
Exposure Period	96 hrs
Statistical Methods	LC50 and 95% confidence limits were calculated by method of Thompson and Weil (1952, Biometrics 8: 51-54).
Test Conditions Note: Concentration prep., vessel type, volume, replication, water quality parameters, environmental conditions, supplier of organisms, age, size, weight, loading	Individual test material exposure solutions were prepared as WAFs by adding ratios of test material to dilution water equivalent to 32, 56, 100, 180, and 320mg/L, stirring with a propeller stirrer for 24 hr at 14^0C. After settling for approx. 1hr, WAFs were withdrawn via a siphon into 2 replicate 20liter test vessels/dose group. Ten juvenile fish were introduced into each vessel containing 19cm of either test media or diluent water, an initial loading rate of 0.46g body wt/liter. Animals were exposed for 96 hrs without renewal. Fish were not fed for 48 hrs prior to or during exposure; supplementary aeration was not provided. Average size of fish was determined by measuring control fish at end of exposure: mean std. length= 4.3±0.23cm, mean wt.= 0.92±0.14g. Exposure temperature was 14 ± 1^0C, photoperiod was 16hr light/8hr dark (light intensity not specified); pH increased from 7.5 to 7.9 with increasing dose; mg dissolved O_2/liter was 7.8-8.2 in controls and doses up to 180mg/L, and 9.6-9.8 at 320mg/L (WAF). TC/TOC analysis was not performed at 96 hr since values obtained at 0 hr indicated that TC(dissolved) analysis was not appropriate for verification of HPG(WAF) concentrations; exposure media results were similar to control levels. Criteria for death were absence of respiratory movement and absence of response to physical stimulation of caudal peduncle.
Results	
Units/Value: Note: Deviations from protocol or guideline, analytical method, biological observations, control survival	24 hr LC_{50} = 230mg/L; 48 hr and 72 hr LC_{50} = 180mg/L 96 hr LC_{50} = 170mg/L. 100% mortality occurred at 320mg/L by 24 hrs. Other marked reactions to exposure at 180 and 320mg/L were lethargy, loss of equilibrium and moribundity.
Conclusions (study author)	The 96 hr LC_{50} for Hydrogenated Pyrolysis Gasoline WAF in rainbow trout is 170mg/L (95% CL= 150-200) based on nominal values. The no observed effect level (NOEL) is 100 mg/L (WAF)
Data Quality *Reliabilities*	**2.** Reliable with restriction. Analytical method was inappropriate.
Reference	Douglas, M.T. 1993. Hydrogenated pyrolysis gasoline (Water accommodate fraction) Acute toxicity to Rainbow trout (Oncorrhynchus mykiss). CRTC Ref. #92-79. Huntingdon Research Centre, Ltd., Cambridgeshire, England, for Chevron Research and Technology Co., Richmond, CA
Other *Last changed*	Revised 7/27/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary – Group 5: High Benzene Naphthas

Algal Toxicity

Test Substance	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9. 100% pure, colorless liquid.. Composition and stability referred to sponsor.
Method	
Method/guideline followed	OECD Guideline #201, US EPA 40CFR 797.1050
Year (guideline)	1992
Type (test type)	Algae acute toxicity- Water accommodated fraction (WAF)
GLP	Yes
Year (study performed)	1993
Species	Fresh water green algae (Selenastrum capricornutum), strain # CCAP278/4 from Freshwater Biological Assoc. Cumbria, UK
Analytical Monitoring	Yes. Total carbon analysis using Ionics TC/TOC Model 555 with infrared gas analyzer to verify test conc. at 0, 62.5 and 1000mg/L (WAF) at 0 and 96 hrs.
Exposure Period	96 hrs
Statistical Methods	None specified
Test Conditions Note: Concentration prep., vessel type, volume, replication, water quality parameters, environmental conditions, age.	Individual test material solutions were prepared as WAF by adding ratios of test material to dilution water equivalent to 62.5, 125, 250, 500 and 1000mg/L, stirred on a magnetic stirrer for 24 hr at 24^0C. After settling for approx. 1hr, WAFs were withdrawn by siphon and 100ml measured into 250 ml conical flasks. Two ml of algal suspension in log phase (0.802 absorbance at 665nm) were added to each of 3 flasks/dose level. Cultures were incubated without media renewal for 96 hrs under continuous illumination of approx. 7000 lux, provided by 7x30W "warm white " 1 meter fluorescent tubes in a Gallenkamp Illuminated Orbital Incubator at 24 ± 1^0C and oscillation of 120 cycles/min. Samples were taken at 0, 24, 48, 72 and 96 hr and absorbance measured in a spectrophotometer at 665nm wavelength. Cell densities of control cultures were counted with a haemocytometer at initiation and study termination. pH values ranged from 7.8-8.0 at initiation and 7.6-8.4 at 96 hrs. Index of growth was calculated from the area under the growth curve; percent inhibition of growth at each dose was calculated by comparing the area under test curve with control. Median effective conc. for inhibition of growth (EbC_{50}) is based on comparison of areas under growth curves after 72 and 96 hrs. Avg. max growth rate is calculated from the log phase of growth curve for each culture. ErC_{50} is the median effective conc. for inhibition of growth based on comparison of max growth (24-48 hrs).
Results Units/Value: Measurement (cells/growth) Note: Deviations from protocol or guideline, analytical method, biological observations, control survival	Mean cell densities of control cultures at initiation (0 hr)= $8.91x10^4$ cells/ml and at termination (96 hrs) = $2.41x10^6$ cells/ml. No cultures were contaminated and no abnormalities were seen in any culture upon microscopic examination at 96 hrs. Total dissolved carbon was 7.1, 7.0, 17.2 mg/L at initiation and 9.7, 7.9 and 13.0mg/L at 96hrs for 0(control), 62.5 and 1000 mg/L (WAF) respectively. Biomass: EbC_{50} (72 hr) >1000 mg/L (WAF); EbC_{50} (96 hr) >1000 mg/L (WAF) Growth rate: ErC_{50} (24-48hr) >1000mg/L (WAF) NOAEL = 125mg/L
Conclusions (study author)	Hydrogenated pyrolysis gasoline is not inhibitory to the growth of Selenastrum capricornutum at conc of 125mg/L (WAF). EbC_{50} (96hr) and ErC_{50} (24-48hrs) are both >1000mg/L (WAF).
Data Quality *Reliabilities*	**1.** Reliable without restriction
Reference	Douglas, M.T. 1993. Hydrogenated pyrolysis gasoline (Water accommodated fraction) Algal Growth Inhibition. CRTC Ref. #92-81. Huntingdon Research Centre, Ltd, Cambridgeshire, England, for Chevron Research and Technology Co, Richmond, CA
Other *Last changed*	5/10/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary – Group 5: High Benzene Naphthas

Biodegradation

Test Substance	Hydrogenated Pyrolysis Gasoline, CAS #68410-97-9 100% pure, colorless liquid.. Composition and stability referred to sponsor.
Method	
Method/guideline followed	OECD guideline 301D; EEC directive 67/548 Annex V part C.6 (84/449/EEC)
Year (guideline)	1984
Type (test type)	Aerobic Aquatic Biodegradation (Closed Bottle Test)
GLP	Yes
Year (study performed)	1993
Inoculum	Domestic activated sewage sludge bacteria from Huntingdon Research Centre sewage treatment plant.
Exposure Period	28 days
Test Conditions Note: Concentration prep., vessel type, replication, test conditions.	Hydrogenated pyrolysis gasoline (HPG, 2mg/L) was added, via a Hamilton microliter syringe to reduce loss of volatile constituents, to culture bottles containing inorganic nutrient medium with or without activated sewage sludge bacteria. The nutrient medium consisted of aerated reverse osmosis purified, deionized water, phosphate buffer, magnesium sulfate, calcium chloride and ferric chloride. Activated sewage sludge filtrate was added at a rate of 1 drop of inoculum/liter. Glass 500ml culture bottles covered in foil, fitted with plastic screw caps and PTFE faced sealing discs of ethylene propylene, were filled by siphon and tightened to exclude all air bubbles. Duplicate bottles were prepared in each test and control series to allow single oxygen determination/bottle at 0, 5, 15, and 28 days. Sodium benzoate (3mg/L), the standard substance, was dispensed directly into sludge-inoculated nutrient medium, or added to a sludge-inoculated medium containing 2mg/L HPG. The bottles containing HPG+sodium benzoate were sampled on day 0 and 28 only to examine inhibitory effects. All bottles were incubated in a water bath at 20 ± 1^0C; measurements of dissolved oxygen conc. were made with a Yellow Springs BOD meter. Concentrations of HPG or sodium benzoate as mg carbon/L were not provided.
Results Units/Value: Note: Deviations from protocol or guideline, analytical method.	Percent biodegradation values were calculated as % of Theoretical Oxygen Demand (NO_3); $TOD_{(NO3)}$ was $3.15mgO_2/mg$ for HPG and $1.67mgO_2/mg$ for sodium benzoate. Hydrogenated pyrolysis gasoline attained 68% biodegradation within 28 days but did not degrade 60% within 10 days of exceeding the 10% degradation level. HPG is thus not readily biodegradable. Sodium benzoate degraded 86% within 28 days. Cultures containing both HPG and sodium benzoate showed an oxygen depletion value 5% lower than separate cultures. HPG is not considered to have an inhibitory effect on sewage bacteria.
Conclusions (study author)	Hydrogenated pyrolysis gasoline is not readily biodegradable but is considered ultimately biodegradable. No inhibitory effects on sewage bacteria were observed in this assay.
Data Quality *Reliabilities*	**1.** Reliable without restriction
Reference	Douglas, M.T. 1993. Hydrogenated Pyrolysis Gasoline Ready Biodegradability (Closed Bottle Test). CRTC Ref. #92-82. Huntingdon Research Centre Ltd. Cambridgeshire England for Chevron Research and Technology Co., Richmond, CA
Other *Last changed*	5/10/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Pyrolysis gasoline (Rerun Tower Overheads) Yellow, homogeneous liquid, stable for 5 years at ambient temperature.
Method	
Method/guideline followed	Not specified
Type (test type)	Acute, limit test
GLP	Yes
Year	1994
Species/Strain	Rat, Sprague-Dawley
Sex	Males and females
No. of animals per sex per dose	5
Vehicle	None
Route of administration	Oral gavage
Test Conditions	Sprague Dawley rats (180-350g) were individually housed in stainless steel suspended cages and fasted overnight prior to administration of 2g/kg neat pyrolysis gasoline. The study room was maintained at 68-72^{0}F with a relative humidity of 35-63% and a 12 hr light-dark cycle. Water and chow diet were available ad lib after dosing. Test article was administered once on day 1 by oral gavage through a blunted needle. Rats were observed for clinical signs approx. 30 min, 1hr and 4hr, after dosing, and daily thereafter until sacrifice on day 15. Rats were checked once a day for mortality and moribundity. Observations were not made on weekends. Body wts were recorded prior to fasting and on days 1, 8 and 15.
Results	
LD_{50} with confidence limits.	The LD_{50} was not reached at 2g/kg. There were no deaths and all rats gained some weight during the study. Clinical signs noted in one or more rats were salivation, decreased activity, rales, lacrimation, chromodacryorrhea, ataxia, chromorhinorrhea, miosis, slight tremors, mydriasis, hyperactivity, hypothermia, urogenital discharge, nasal discharge, decreased food consumption, decreased fecal output, vocalization, and penile discharge. No gross pathological findings were noted at necropsy.
Remarks	
Conclusions (study author)	The LD_{50} was not reached at 2g/kg.
Data Quality	
Reliability	**1.** Reliable without restriction.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Acute oral toxicity of pyrolysis gasoline in Sprague Dawley Rats. Study #65636. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ.
Other	
Last changed	10/16/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Pyrolysis gasoline (Rerun Tower Overheads). Yellow, homogeneous liquid, stable for 5 years at ambient temperature. (CRU #93328)
Method	
Method/guideline followed	Not specified
Type (test type)	Acute, limit test
GLP	Yes
Year	1994
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	3
Vehicle	None
Route of administration	dermal
Test Conditions	Rabbits, weighing at least 2kg, were individually housed in stainless steel suspended cages in a study room maintained at 69-72^{0}F with a relative humidity of 38-85% and a 12 hr light-dark cycle. Water and chow diet were available ad lib. The dorsal skin surface extending down from the front to rear legs and from left to right lower flanks was clipped free of hair the day prior to test article administration. Test article was spread evenly over the clipped area (approx. 10% of body surface area) at a dose of 2g/kg. A layer of 8-ply gauze was placed on the dorsal site, and a rubber dam sleeve was fitted snugly over the gauze pad and around the trunk. Edges of the dam were taped in place. An Elizabethan collar was affixed to the neck to prevent oral ingestion of test article and mechanical irritation of the test site. After 24 hrs, the collar and wrappings were removed and residual test article was wiped off. Body wts were recorded on days 1, 8 and 15. Rabbits were observed for toxicity at about 1 and 2 hr post-dose and daily thereafter on weekdays through day 14. Observations for mortality/moribundity were made daily. Rabbits were sacrificed on day 15 and necropsies were performed.
Results	
LD_{50} with confidence limits.	The LD_{50} was not reached at 2g/kg. There were no deaths during the study and rabbits either gained some weight or remained at day 1 body wt. Signs that might have resulted from treatment in one or more rabbits were: soft stool, decreased fecal pellet size, nasal discharge, and test site erythema. No gross pathological findings were noted at necropsy.
Remarks	
Conclusions (study author)	The LD_{50} was not reached at 2g/kg.
Data Quality Reliability	**1.** Reliable without restriction.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Dermal toxicity of pyrolysis gasoline in the New Zealand White rabbit. Study #65637. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ.
Other	
Last changed	10/16/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Pyrolysis gasoline (rerun tower overhead). Yellow, homogeneous liquid. Stable for 5 years at ambient temperature. (CRU #93328)
Method	
Method/guideline followed	Not specified.
Type (test type)	Acute irritation
GLP	Yes
Year	1994
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	3
Vehicle	None
Route of administration	Dermal
Test Conditions	Three males and 3 female rabbits, weighing at least 2kg, were individually housed in stainless steel suspended cages in a room maintained at 69-72^{0}F with relative humidity of 38-85% and 12hr light-dark cycle. Water and chow diet were available ad lib. One 1sq. inch test site was selected on the right anterior flank of 4 animals and the left anterior flank of 2 animals. The sites were designated as anterior flank (1-hr occlusion) test sites. A second 1 sq. inch test site was selected on the right posterior flank of 4 animals and the left posterior flank of 2 animals. The sites were designated as posterior flank (4-hr occlusion) test sites. The test sites were not abraded. 0.5ml of test substance was applied to the posterior test site under 1 sq. inch Webril patch. The patch was secured to the skin with an occlusive rubber dam followed by surgical tape. 0.5ml of test substance was applied to the anterior test site under a 1 sq. inch patch and similarly secured. Following 1hr exposure, the anterior patch was removed and the site evaluated for DOT corrosion. This site was reevaluated at 48hrs post-dosing. After the initial evaluation, residual test substance was removed by gently wiping the site with saline dampened cotton. Following a 4hr exposure, the posterior patch was removed and the site evaluated for DOT corrosion and OSHA Primary Irritation Index (PII). This site was reevaluated at 48hrs post-dosing. After the initial evaluation, the residual test substance was removed by gently wiping the site with saline dampened cotton. The posterior test site was also evaluated for dermal irritation according to the Draize method at 4.5, 28, 52, and 76hrs and at 7, 10 and 14 days post-dosing. Clinical observations were recorded at approx. 1hr and 4hr post-dosing and daily thereafter. The condition of each animal was checked once daily in the morning. The rabbits in this study were concurrently evaluated for ocular irritation to reduce the number of animals used. (Study 65638, see separate summary)
Results	The test material was negative for DOT corrosion after 1hr and 4hr occlusions, and 48hr post-dose. After the 4hr occlusion, the 4.5hr to 14day post-dose Draize scores for erythema and edema varied between 2.2 and 3.2, and 1.5 to 3.3, respectively, with no trend over time. The OSHA PII score was 4.7, corresponding to a rating of "non-irritant".
Remarks	Diarrhea, soft stool, decreased fecal pellet size and nasal discharge were observed during the study.
Conclusions (study author)	The test article was rated non-corrosive by DOT criteria after 1hr and 4hr occlusions, and non-irritating by OSHA PII criteria.
Data Quality	
Reliability	**1.** Reliable without restrictions.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Acute dermal irritation/corrosion of pyrolysis gasoline in the New Zealand White rabbit. Study #65639. Stonybrook Laboratories, Inc., Princeton, NJ. for Mobil Chemical Co., Edison, NJ
Other	
Last changed	10/23/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Acute Toxicity

Test Substance	Pyrolysis gasoline (Rerun Tower Overheads). Yellow, homogeneous liquid, stable for 5 years at ambient temperature. (CRU #93328)
Method	
Method/guideline followed	Not specified
Type (test type)	Acute irritation
GLP	Yes
Year	1994
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	3
Vehicle	None
Route of administration	Instillation into conjunctival sac
Test Conditions	Rabbits, weighing at least 2kg, were individually housed in stainless steel suspended cages in a study room maintained at 69-72^{0}F with relative humidity of 38-85% and a 12 hr light-dark cycle. Water and chow diet were available ad lib. The left eye was designated as the test eye and the right eye served as untreated control; 0.1ml of test article was instilled into the left conjunctival sac of 3 males and 3 females. Both eyes were grossly examined and the test eye was scored according to the Draize method at 1, 24, 48 and 72 hrs post-dose. The rabbits tested in this study were also concurrently evaluated for dermal irritation/corrosion to reduce the number of animals used (Study #65639 - see separate summary).
Results	
Remarks	Cornea and iris were not affected by treatment, however conjunctivae yielded Draize scores of 13.7 (1hr); 3.7 (24hr); 2.3 (48hr) and 0.7 (72hr).
Conclusions	
(study author)	Pyrolysis gasoline produced conjunctival irritation shortly after instillation that cleared almost completely by 72 hrs.
Data Quality	
Reliability	**1.** Reliable without restriction.
References	Rodriguez, S.C. and Dalbey, W.E. 1994. Ocular irritation of pyrolysis gasoline in the New Zealand White rabbit. Study #65638. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ. Rodriguez, S.C. and Dalbey, W.E. 1994. Acute dermal irritation/corrosion of pyrolysis gasoline in the New Zealand White rabbit. Study #65639. Stonybrook Laboratories, Princeton, NJ. for Mobil Chemical Co., Edison, NJ.
Other	
Last changed	10/16/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary - Group 5: High Benzene Naphthas

Genetic Toxicity - in Vitro

Test Substance	Rerun Tower Overheads from Olefins/Aromatics Plant (light thermal cracked naphtha)
Test substance	CAS # 64741-74-8. Straw colored liquid; 40% benzene, 26% C5, 13% toluene, 20% C4, C6-C8 and xylene.
Method	
Method/guideline followed	Standard method based on Ames et al, 1975
Type	Reverse mutation bacterial assay
System of testing	Salmonella typhimurium with and without metabolic activation
GLP	Yes
Year	1981
Species/Strain	S. typhimurium TA 98, TA100, TA1535, TA1537, and TA1538.
Metabolic activation	Yes
Species and cell type	Sprague Dawley male rat liver (S9 fraction) from Litton Bionetics, Kensington, MD
Quantity	50ul S9 fraction in 0.5ml S9 mix/plate
Induced or not induced	Aroclor 1254-induced, rats were given a single ip 500mg/kg dose, 5 days prior to sacrifice.
Concentrations tested	0, 0.029, 0.094, 0.30, 0.97µl/plate –S9, and 0.094, 0.30, 0.97, and 3.1µl/plate + S9; samples diluted in dimethyl sulfoxide (DMSO). Negative control 50µl DMSO
Statistical Method	None. Criteria for a positive response were an increase in revertant colonies at least two-fold that of negative control at the lowest active dose, and a dose response curve. Positive results must be reproducible in an independent repeat assay.
Remarks for Test Conditions	Rerun tower overheads test solutions were prepared in DMSO immediately prior to use. Salmonella (Approx. 1.4-2x10^8 cells/ml) were exposed to either test solution or DMSO ±S9 by the preincubation method. Doses of 0.029-0.97µl/plate-S9 and 0.094-3.1µl/plate +S9 were determined by a pretest toxicity test in TA 100 and TA1537±S9 using incremental doses from 0.01-10µl/plate. Culture tubes containing 50µl test solution or DMSO, 0.1ml Salmonella and 0.5 ml phosphate buffer or S9 mix were combined and incubated with shaking (150 rpm) for 20 minutes at 37^0C. At the end of the preincubation period, top agar was added, mixed and cultures were overlaid on minimal agar plates, 3 plates/dose/strain. Plates were incubated at 37^0C for 48 hrs, then counted automatically (Biotran II) and background lawn evaluated by stereomicroscope. Positive control compounds were: -S9, 2-nitrofluorene (2-NF, 20µg/plate) for TA98 and TA1538; N-methyl-N'-nitro-N-nitrosoguanidine (MNNG, 2.0µg/plate) for TA100 and TA1535; 9-aminoacridine (9-AA, 25µg/plate) for TA1537; +S9 2-aminoanthracene (2µg/plate) for all strains except TA1537.
Results	
Genotoxic effects	The preliminary toxicity test exhibited severe toxicity at 10µl/plate with activation and at 3.1 and 10µl/plate without activation (individual data not shown). In the mutagenicity test, none of the 5 strains of Salmonella exhibited revertant frequencies substantially different from the solvent or spontaneous controls at any dose level with or without metabolic activation (e.g. TA98-S9: 16, 15, 12, 12, and 0 average revertants/plate and TA100-S9: 111, 115, 107, 94, and 0 at 0[DMSO], 0.029, 0.094, 0.30, and 0.97µl/plate, respectively: TA98+S9: 33, 26, 26, 22, and 0 revertants/plate, and TA100+S9: 128, 161, 128, 118, and 0 revertants/plate at 0[DMSO], 0.094, 0.30, 0.97 and 3.1µl/plate, respectively). Clearing of background lawn and microcolonies were observed at the maximum doses (0.97µl/plate-S9; 3.1µl/plate+S9). Positive control compounds (2 plates/strain) performed appropriately (-S9: MNNG 1906, 1883 revertants/plate in TA 100 and TA1535, respectively; 9-AA 586 revertants/plate in TA1537; 2-NF 2114, 1214 revertants/plate in TA98 and TA1538, respectively; and +S9 2-aminoanthracene 406-2307 revertants/plate for all strains except TA1537). The results of this assay indicate that rerun tower overheads had no mutagenic activity in this test system. (Reviewer's note: Due to toxicity, tests were performed over a low dose range; 3 of 4 doses were non-toxic and showed sufficient growth to evaluate mutagenicity. Testing at any lower doses was impractical).
Conclusions	Rerun Tower Overheads did not induce an increase in revertant colonies in any Salmonella

(contractor)	strain, tested at any dose level with or without metabolic activation in this single Ames test.
Data Quality *Reliabilities*	**1.** Reliable without restriction
Reference	Blackburn, G.R. 1981. An Ames Salmonella/mammalian microsome mutagenesis assay for the determination of potential mutagenicity of Rerun Tower Overheads from an olefins/aromatics plant. Study No. 1781-80. Mobil Environmental and Health Sciences Laboratory, Princeton, NJ. Ames B. N. et al. 1975. Mutat. Res. 31: 347-364.
Other *Last changed*	10/02/2001 (Prepared by a contractor for the Olefins Panel)

Genetic Toxicity - in Vitro

Test Substance	Rerun tower overheads (RT0, 0818805). Compositional analysis, stability and purity
Test substance	referred to sponsor
Method	
Method/guideline followed	Standard method, no guideline specified
Type	Cell transformation
System of testing	Mouse embryo cells
GLP	Yes
Year	1981
Species/Strain	BALB-c/3T3 mouse cell line
Metabolic activation	No
Species and cell type	NA
Quantity	NA
Induced or not induced	NA
Concentrations tested	Initial cytotoxicity: 0, 0.01, 0.1, 1.0, 10.0, 100.0µg/ml medium; Transformation: 0. 0.8, 4.0, 20.0 and 100µg/ml, diluted in dimethyl sulfoxide. Negative control was DMSO at 2.5% vol. concentration.
Statistical Method	T-test specified. Standard criteria for positive response is a two fold increase in type III foci at highest dose over vehicle control with or without a dose related response or a 2 fold increase at 2 or more consecutive doses.
Remarks for Test Conditions	Routine procedures were referred to Appendix 1 Standard Operating Procedures, which was not included with this report. Only specifics unique to this assay are presented. Due to the volatile nature of test material, the cytotoxicity assay and transformation assays were conducted in tightly capped T-25 flasks in sealed plastic bags. The pH of medium during the 72hr exposure period was maintained at 7.4 by 0.02M Hepes buffer in flasks. RTO was prepared as a 1% stock solution in DMSO, which, when added to culture medium at a 2.5% vol. conc. was a suspension. Despite limited solubility, RTO produced a dose-dependent cytotoxic effect after a 3-day exposure period. In the initial toxicity assay, RTO was added to flasks, seeded with BALB-c/3T3 cells, at concentrations of 0, 0.01, 0.1, 1.0, 10.0 and 100.0µg/ml, incubated for 3 days at 37^0C in a CO_2 in air incubator, after which cells were counted for survival. In the transformation assay, RTO was tested at 0, 0.8, 4.0, 20.0 and 100µg/ml. In a standard BALB-c/3T3 transformation assay, colony formation cultures (approx. 100 cells/culture) and transformation cultures (approx. 10^4 cells/culture, 20 cultures/dose) were seeded on day 1, exposed to test material for 2-3 days, and culture medium was changed on day 4. For transformation cultures, medium continued to be changed weekly to day 29. Colony formation cultures were fixed, stained and counted visually on day 8 to determine cloning efficiency; transformation cultures were fixed and stained on day 29 for focus counting and evaluation. Transformation frequency = total type III foci ÷ total cultures/dose. Positive control compound was 3-methyl cholanthrene (2µg/ml).
Results	
Genotoxic effects	RTO induced toxicity in BALB-c/3T3 cells after 3 days exposure at concentrations of 10µg/ml (59% viability) and at 100µg/ml (18% viability). In the transformation assay, inhibition of cloning efficiency (CE, clones/100 cells) occurred at 4.0µg/ml (89% CE), 20.0µg/ml (81% CE) and 100µg/ml (65% C.E.); cell toxicity was somewhat less than in the initial cytotoxicity assay [40% viability at 100µg/ml]. RTO did not induce statistically significant increased incidence of transformed foci compared to negative controls at any dose level. Values were 0.10 foci/flask, 2/20 flasks with foci at 100µg/ml, 0.0 foci/flask, 0/20 flasks with foci at 20.0µg/ml, 0.15 foci/flask, 3/20 flasks with foci at 4.0µg/ml, 0.10 foci /flask, 2/20 flasks with foci at 0.8µg/ml compared to 0.05 foci/flask, 1/20 flasks with foci in negative control group. [Reviewer's note: Negative control value of 1 focus/20 flasks was lower than control values in other concurrent studies on 2 other compounds in this series where negative controls had 4 foci in 20 flasks (0.20 foci/flask)]. Positive control compound, 3 methyl cholanthrene, induced 56 foci/19 flasks (2.95 foci/flask),

	18/19 flasks with foci.
Conclusions (contractor)	Rerun tower overheads did not induce neoplastic transformation in BALB-c/3T3 cells and was not active in this test system.
Data Quality *Reliabilities*	**2.** Reliable with restrictions. Complete details of assay methods are not included in the report. Specifics of statistics are not supplied.
Reference	Tu, A.S. and Sivak, A. 1981. BALB-c/3T3 Neoplastic transformation assay on 0818802, 08188003 and 08188005 (Rerun tower overheads). ALD Ref. #86374. Arthur D. Little, Inc. Cambridge, MA for Mobil Oil Corp, Study #1771-80, Princeton, NJ Roy, T.A., 1981. Analysis of rerun tower bottom oil by combined capillary gas chromatography/mass spectrometry. Study #1272-81-. Toxicology division, Mobil Oil Co., Princeton, NJ
Other *Last changed*	12/07/01 (Prepared by a contractor to the Olefins Panel)

Developmental Toxicity/Teratogenicity

Test Substance	
Remarks	Rerun Tower Overheads, light thermal cracked naphtha, CAS #64741-74-8. Unsaturated hydrocarbons in C4-C8 range; boiling over 20-120^{0}C (68^0-248^{0}F); approximately 40% benzene, 26% C5, 13% toluene, 20% C4, C6-C8 and xylene.
Method	
Method/guideline followed	Standard method, no guidelines specified
Test type	Teratology
GLP	Yes
Year	1981
Species	Rabbit
Strain	New Zealand white
Route of administration	Oral gavage
Concentration levels	0,10, 25 and 50mg/kg/day in Mazola® corn oil
Sex	Female; 16 pregnant rabbits/group
Exposure period	Days 6-28 of gestation
Frequency of treatment	Once/day
Control group and treatment	16 pregnant rabbits; 0.5ml corn oil/kg/day
Duration of test	32 days (from artificial insemination to Caesarean section on day 29 of gestation)
Statistical methods	Chi-square test with Yates's correction for 2x2 contingency tables and/or Fisher's exact probability test used for male/female sex distribution and number of litters with malformations. Mann-Whitney U test to compare number of early and late resorptions, and postimplantation losses. Analysis of variance (one-way), Bartlett's test and T-test (for equal and unequal variance) with Dunnett's multiple comparison tables used to compare mean number of viable fetuses, total implantations, corpora lutea and mean fetal body weights. All comparisons at $p<0.05$.
Remarks for Test Conditions.	Sixty-four sexually mature, virgin NZW female rabbits (7 months old, 3.4 - 4.2kg) were ear-tagged and individually housed in suspended wire cages in a room with temperature and humidity control (data not presented), a 12 hr light-dark cycle and special ventilation due to volatility of test sample. Purina Certified Rabbit Chow® and tap water were available ad lib. Sperm was collected from each of 6 proven NZW breeder males, using an artificial vagina. Semen was immediately evaluated for motility and used for insemination only if motility was =55%. Useable ejaculate was diluted with 0.9%NaCl at 35^{0}C; 0.25-0.50ml of dilute semen introduced into the anterior vagina. Ovulation was induced by injection of 100 units of chorionic gonadotropin (Ayerst, NY) in the marginal ear vein of the female immediately after insemination. Semen from each male was used to inseminate an equal number of females in each group. Insemination was performed over 2 days; day of insemination was designated day 0 of gestation. Rerun tower overhead test solutions were prepared daily in corn oil and shaken by hand to ensure proper mixing. No analysis of dosing solution compositions was provided. Dosage levels of 0, 10, 25 and 50mg/kg/day were administered at a constant volume of 0.5ml/kg by oral gavage once daily from day 6-28 of gestation. Individual doses were determined from body wt recorded on gestation day 6. Dams were observed daily for mortality, overt changes in appearance and behavior, and clinical signs of toxicity during treatment. Maternal body wts were recorded on gestation days 0, 6, 12, 18, 24 and 29. On gestation day 29, all females were sacrificed by an overdose of sodium pentobarbital in the marginal ear vein; the uterus was excised and weighed prior to removal of fetuses. Number and location of viable and non-viable fetuses, early and late resorptions, total implantations and corpora lutea were recorded. Abdominal and thoracic cavities and organs of dams were examined grossly and the carcasses discarded. Uteri from females that appeared non-gravid were opened and placed in 10% ammonium sulfide solution to confirm pregnancy status. All fetuses were weighed individually and examined for external malformations and variations. Each fetus was dissected, internally sexed and examined for visceral malformations and variations, including brain by a mid-coronal slice and heart by Staples technique (Staples, 1974). Eviscerated, skinned fetuses were

	numbered and tagged for identification, fixed, mascerated and stained with Alizarin Red S for skeletal evaluation..
Results	
NOAEL maternal toxicity	NOAEL maternal= 25mg/kg (based on one female aborting on gestation day 19)
NOAEL developmental toxic ity	NOAEL developmental = 50mg/kg (based on 2 malformations) Assigned by reviewer. In a preliminary study, rerun tower overheads was administered undiluted to 16 mated female rabbits/group at 0, 10, 25 and 50mg/kg/day. Forty-two rabbits died between day 8-29 of gestation, of which 6 aborted prior to death and 6 aborted and were sacrificed. Total dead or aborted and sacrificed animals were 14/16, 11/16, 10/16, and 13/16 in 0(untreated control), 10, 25, and 50mg/kg/day, respectively. Intubation errors or respiratory disorders were determined to be probable cause of deaths; extremely high mortality in control group negated any meaningful comparisons of any parameters with treated groups. Study was repeated at same doses of rerun tower overheads diluted in corn oil.
Maternal effects	Maternal survival was 100% in all groups. Slight increase in occurrence of matted hair coat (nasal region) and slight reduction in fecal material was noted in 50mg/kg group only. One rabbit (50mg/kg) aborted on gestation day 19 and remained on study until scheduled sacrifice; aborted material was discarded. At Caesarean section, congested consolidated or emphysematous lungs and hydrocele(s) on the oviduct(s) were noted with similar frequency in all groups including controls. There were no biologically meaningful differences in mean maternal body wt, body wt gain or adjusted mean body wt (body wt exclusive of uterus and contents) in any treated group compared to controls. [Reviewer's comment: Maternal body wt data did not appear to be statistically analyzed.]
Embryo/fetal effects	There were no biologically meaningful or statistically significant differences in mean number of corpora lutea, total imp lants, early and late resorptions, postimplantation loss, viable fetuses, fetal sex distribution or mean fetal body wts in any treated group compared to controls. No significant differences were present in number of litters with malformations or genetic or developmental variations in treated groups compared with controls. In the 50mg/kg./day group, 1 pup in 1 litter had an atlas-occipital anomaly of the skeleton and one pup in 1 litter had an enlarged heart with an interventricular spetal defect, interrupted aortic arch and retroesophophageal left subclavian vessel (sexes not specified). Scoliosis was observed in all groups including controls. All malformations were within historical ranges for the laboratory.
Conclusions (study authors)	Rerun Tower Overheads did not induce significant maternal or fetal toxicity or significant malformations/variations in offspring of New Zealand White rabbits treated with oral doses of 10, 25, and 50mg/kg/day in corn oil from day 6-28 of gestations.
Data Quality	
Reliabilities	**2.** Reliable with restrictions. No analysis of dosing solution to verify correct test material volume was performed.
References	Miller, L.G. and Schardein, J.L. 1981. Rerun Tower Overheads: Teratology study in rabbits (MCTR-171-79). IRDC study #450-011a. International Research and Development Corp., Mattawan, Mich. for Mobil Oil Corp., Princeton, NJ Staples, R.E. 1974. Teratology 9: A37-A38.
Other	
Las*t changed*	10/09/2001 (Prepared by a contractor to the Olefins Panel)